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**AERONAUTICS**

Includes aeronautics (general); aerodynamics; air transportation and safety; aircraft communications and navigation; aircraft design, testing and performance; aircraft instrumentation; aircraft propulsion and power; aircraft stability and control; and research and support facilities (air).

For related information see also *Astronautics.*

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For related information see also *34 Fluid Mechanics and Heat Transfer.*

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Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxiliary power plants for aircraft.

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## ASTRONAUTICS

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For life support systems see *54 Man/System Technology and Life Support.* For related information see also *05 Aircraft Design, Testing and Performance, 39 Structural Mechanics,* and *16 Space Transportation.*

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## CHEMISTRY AND MATERIALS

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**29 MATERIALS PROCESSING** N.A.

Includes space-based development of products and processes for commercial application.

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## ENGINEERING

Includes engineering (general); communications and radar; electronics and electrical engineering; fluid mechanics and heat transfer; instrumentation and photography; lasers and masers; mechanical engineering; quality assurance and reliability; and structural mechanics.

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**45 ENVIRONMENT POLLUTION 2906**

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Includes aeronomy; upper and lower atmosphere studies; ionospheric and magnetospheric physics; and geomagnetism.

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Includes weather forecasting and modification.

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Includes biological, dynamic, and physical oceanography; and marine resources.

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## LIFE SCIENCES

Includes life sciences (general); aerospace medicine; behavioral sciences; man/system technology and life support; and space biology.

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Includes physiological factors; biological effects of radiation; and effects of weightlessness on man and animals.

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Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

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Includes human engineering; biotechnology; and space suits and protective clothing.

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**55 SPACE BIOLOGY 2920**

Includes exobiology; planetary biology; and extraterrestrial life.

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Includes mathematical and computer sciences (general); computer operations and hardware; computer programming and software; computer systems; cybernetics; numerical analysis; statistics and probability; systems analysis; and theoretical mathematics.

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**60 COMPUTER OPERATIONS AND HARDWARE 2920**

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For components see *33 Electronics and Electrical Engineering.*

**61 COMPUTER PROGRAMMING AND SOFTWARE 2920**

Includes computer programs, routines, algorithms, and specific applications, e.g., CAD/CAM.

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Includes feedback and control theory, artificial intelligence, robotics and expert systems.

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Includes data sampling and smoothing; Monte Carlo method; and stochastic processes.

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Includes mathematical modeling; network analysis; and operations research.

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Includes topology and number theory.

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Includes physics (general); acoustics; atomic and molecular physics; nuclear and high-energy physics; optics; plasma physics; solid-state physics; and thermodynamics and statistical physics.

For related information see also *Engineering.*

**70 PHYSICS (GENERAL) N.A.**

For precision time and time interval (PTTI) see *35 Instrumentation and Photography;* for geophysics, astrophysics or solar physics see *46 Geophysics, 90 Astrophysics,* or *92 Solar Physics.*

**71 ACOUSTICS** 2931
Includes sound generation, transmission, and attenuation.
For noise pollution see *45 Environment Pollution.*

**72 ATOMIC AND MOLECULAR PHYSICS** 2933
Includes atomic structure, electron properties, and molecular spectra.

**73 NUCLEAR AND HIGH-ENERGY PHYSICS** 2933
Includes elementary and nuclear particles; and reactor theory.
For space radiation see *93 Space Radiation.*

**74 OPTICS** 2934
Includes light phenomena and optical devices.
For lasers see *36 Lasers and Masers.*

**75 PLASMA PHYSICS** 2936
Includes magnetohydrodynamics and plasma fusion.
For ionospheric plasmas see *46 Geophysics.* For space plasmas see *90 Astrophysics.*

**76 SOLID-STATE PHYSICS** 2937
Includes superconductivity.
For related information see also *33 Electronics and Electrical Engineering* and *36 Lasers and Masers.*

**77 THERMODYNAMICS AND STATISTICAL PHYSICS** 2941
Includes quantum mechanics; theoretical physics; and Bose and Fermi statistics.
For related information see also *25 Inorganic and Physical Chemistry* and *34 Fluid Mechanics and Heat Transfer.*

## SOCIAL SCIENCES

Includes social sciences (general); administration and management; documentation and information science; economics and cost analysis; law, political science, and space policy; and urban technology and transportation.

**80 SOCIAL SCIENCES (GENERAL)** N.A.
Includes educational matters.

**81 ADMINISTRATION AND MANAGEMENT** 2941
Includes management planning and research.

**82 DOCUMENTATION AND INFORMATION SCIENCE** 2942
Includes information management; information storage and retrieval technology; technical writing; graphic arts; and micrography.
For computer documentation see *61 Computer Programming and Software.*

**83 ECONOMICS AND COST ANALYSIS** 2943
Includes cost effectiveness studies.

**84 LAW, POLITICAL SCIENCE AND SPACE POLICY** N.A.
Includes NASA appropriation hearings; aviation law; space law and policy; international law; international cooperation; and patent policy.

**85 URBAN TECHNOLOGY AND TRANSPORTATION** 2943
Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation.
For related information see *03 Air Transportation and Safety, 16 Space Transportation,* and *44 Energy Production and Conversion.*

## SPACE SCIENCES

Includes space sciences (general); astronomy; astrophysics; lunar and planetary exploration; solar physics; and space radiation.
For related information see also *Geosciences.*

**88 SPACE SCIENCES (GENERAL)** N.A.

**89 ASTRONOMY** 2944
Includes radio, gamma-ray, and infrared astronomy; and astrometry.

**90 ASTROPHYSICS** 2945
Includes cosmology; celestial mechanics; space plasmas; and interstellar and interplanetary gases and dust.
For related information see also *75 Plasma Physics.*

**91 LUNAR AND PLANETARY EXPLORATION** 2947
Includes planetology; and manned and unmanned flights.
For spacecraft design or space stations see *18 Spacecraft Design, Testing and Performance.*

**92 SOLAR PHYSICS** 2947
Includes solar activity, solar flares, solar radiation and sunspots.
For related information see *93 Space Radiation.*

**93 SPACE RADIATION** 2948
Includes cosmic radiation; and inner and outer earth's radiation belts.
For biological effects of radiation see *52 Aerospace Medicine.* For theory see *73 Nuclear and High-Energy Physics.*

## GENERAL

Includes aeronautical, astronautical, and space science related histories, biographies, and pertinent reports too broad for categorization; histories or broad overviews of NASA programs.

**99 GENERAL** 2949

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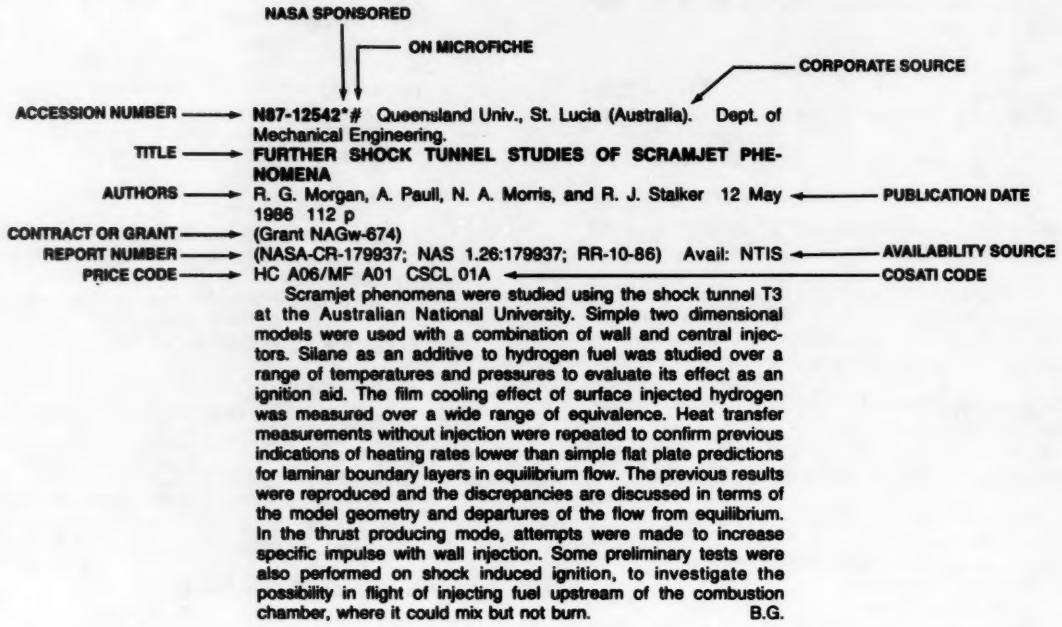
# TYPICAL CITATION AND ABSTRACT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ACCESSION NUMBER
N87-12542*# Queensland Univ., St. Lucia (Australia). Dept. of Mechanical Engineering.
TITLE
FURTHER SHOCK TUNNEL STUDIES OF SCRAMJET PHENOMENA
AUTHORS
R. G. Morgan, A. Paull, N. A. Morris, and R. J. Stalker 12 May 1986 112 p
PUBLICATION DATE
CONTRACT OR GRANT
(Grant NAGw-674)
REPORT NUMBER
(NASA-CR-179937; NAS 1.26:179937; RR-10-86) Avail: NTIS
AVAILABILITY SOURCE
PRICE CODE
HC A06/MF A01 CSCL 01A
COSATI CODE
Scramjet phenomena were studied using the shock tunnel T3 at the Australian National University. Simple two dimensional models were used with a combination of wall and central injectors. Silane as an additive to hydrogen fuel was studied over a range of temperatures and pressures to evaluate its effect as an ignition aid. The film cooling effect of surface injected hydrogen was measured over a wide range of equivalence. Heat transfer measurements without injection were repeated to confirm previous indications of heating rates lower than simple flat plate predictions for laminar boundary layers in equilibrium flow. The previous results were reproduced and the discrepancies are discussed in terms of the model geometry and departures of the flow from equilibrium. In the thrust producing mode, attempts were made to increase specific impulse with wall injection. Some preliminary tests were also performed on shock induced ignition, to investigate the possibility in flight of injecting fuel upstream of the combustion chamber, where it could mix but not burn. B.G.

VOLUME 25 NUMBER 21 / NOVEMBER 8, 1987

# Scientific and Technical Aerospace Reports

*A Semimonthly Publication of the National Aeronautics and Space Administration*

## 01 AERONAUTICS (GENERAL)

**N87-26854#** Naval Postgraduate School, Monterey, Calif.
**COST ESTIMATING RELATIONSHIPS FOR FIGHTER AIRCRAFT M.S. Thesis**
Won P. Hong Mar. 1987 60 p
(AD-A180695) Avail: NTIS HC A04/MF A01 CSCL 05C

This thesis presents Cost Estimating Relationships (CERs) for fighter aircraft. Since the fighter aircraft is one of the most important tactical weapon systems, it is very useful to establish CERs solely for fighter aircraft. Using the public data on U.S. fighter aircraft, Ordinary Least Squares (OLS) is used as the primary statistical method of establishing CERs. The data collection techniques and adjustments used are discussed, and simple and multiple linear regressions are performed on various combinations of the explanatory variable. This thesis then shows that CERs based on new fighter aircraft data are more reliable than those based on new and old fighter aircraft data. GRA

**N87-26855#** Aeronautical Systems Div., Wright-Patterson AFB, Ohio.
**A COMPARISON OF AIR FORCE VERSUS FEDERAL AVIATION ADMINISTRATION AIRFRAME STRUCTURAL QUALIFICATION CRITERIA: MIL-A-87221 (USAF) VERSUS FAR PARTS 23 AND 25 Final Report, 15 Aug. 1984 - 15 Aug. 1986**
Patrick J. Long and James E. Ellis Aug. 1986 38 p
(AD-A180922; ASD-TR-86-5018) Avail: NTIS HC A03/MF A01 CSCL 01B

Air Force acquisitions of off-the-shelf commercially developed aircraft for use in cargo, tanker, transport, and trainer roles have made it essential that the capability be developed within Aeronautical Systems Division acquisition organizations to evaluate commercially developed aircraft designs for adequacy in meeting Air Force requirements. Development of this capability to evaluate commercial aircraft designs has been complicated by a lack of understanding of the differences in the design approaches embodied in Air Force and Federal Aviation Administration airframe qualification procedures. This report is intended to provide an insight into Federal Aviation Regulation Parts 23 and 25, the FAA regulations which govern airplane qualification and certification, including airframe structures. This report is intended primarily for use by ASD engineers familiar with Air Force regulations and specifications governing aircraft structural design, particularly MIL-A-87221(USAF). GRA

## 02 AERODYNAMICS

Includes aerodynamics of bodies, combinations, wings, rotors, and control surfaces; and internal flow in ducts and turbomachinery.

For related information see also *34 Fluid Mechanics and Heat Transfer.*

**N87-26856*#** Mississippi State Univ., Mississippi State. Dept. of Aerospace Engineering.
**SOLUTION OF THE EULER EQUATIONS WITH VISCOUS-INVISCID INTERACTION FOR HIGH REYNOLDS NUMBER TRANSONIC FLOW PAST WING/BODY CONFIGURATIONS Final Report**
Keith Koenig [1986] 90 p
(Grant NAG1-362)
(NASA-CR-180288; NAS 1.26:180288) Avail: NTIS HC A05/MF A01 CSCL 01A

The theoretical and numerical bases of a program for the solution of the Euler equations with viscous-inviscid interaction for high Reynolds number transonic flow past wing/body configurations are explained. The emphasis is upon the logic behind the equation development. The program is fully detailed so that the user can quickly become familiar with its operation. Author

**N87-26857*#** Old Dominion Univ., Norfolk, Va. Dept. of Mechanical Engineering and Mechanics.
**SUPERSONIC AERODYNAMIC INTERFERENCE EFFECTS OF STORE SEPARATION. PART 1: COMPUTATIONAL ANALYSIS OF CAVITY FLOWFIELDS Final Report, 16 May 1985 - 15 Jul. 1986**
Oktay Baysal Sep. 1986 75 p
(Grant NAG1-559)
(NASA-CR-180311; NAS 1.26:180311) Avail: NTIS HC A04/MF A01 CSCL 01A

An explicit-implicit and an implicit two-dimensional Navier-Stokes code along with various grid generation capabilities were developed. A series of classical benckmark cases were simulated using these codes. B.G.

**N87-26858*#** Kansas Univ. Center for Research, Inc., Lawrence. Flight Research Lab.
**AN EXPERIMENTAL INVESTIGATION OF DYNAMIC GROUND EFFECT Semiannual Status Report, 19 Sep. 1985 - 15 Mar. 1986**
Pai Hung Lee, C. Edward Lan, and Vincent U. Muirhead 1 Apr. 1986 61 p
(Grant NAG1-616)
(NASA-CR-180305; NAS 1.26:180305; CRINC-FRL-717-1) Avail: NTIS HC A04/MF A01 CSCL 01A

Experimental studies were conducted to determine the longitudinal force and moment aerodynamic coefficients for a 1/48 scale model of an F-106 aircraft and a 0.01 scale model of an XB-70-1 aircraft. The two airplanes and one 60 degree delta wing model were designed and fabricated to satisfy the specific test conditions of the Kansas University wind tunnel with a 3 by 4.3 test section. Results of the tests are given Author

**N87-26859*#** Old Dominion Univ., Norfolk, Va. Dept. of Mechanical Engineering and Mechanics.
**UNSTEADY HYBRID VORTEX TECHNIQUE FOR TRANSONIC VORTEX FLOWS AND FLUTTER APPLICATIONS Progress Report, 16 Feb. - 15 Oct. 1986**
Osama A. Kandil Nov. 1986 34 p
(Grant NAG1-648)
(NASA-CR-180337; NAS 1.26:180337) Avail: NTIS HC A03/MF A01 CSCL 01A

The well developed surface panel method is extended by adding a volume integral term allowing calculation of the full effect of compressibility. The full effect of compressibility is calculated by using mixed type finite difference scheme consistent with the mixed nature of transonic flow. The solution is obtained through successive iteration cycles for subcritical flows and for critical flows the solution is obtained through satisfying the Rankine-Hugoniot relations across the captured shock in addition to the captured shock. The method is applied to airfoils in subcritical and critical flows and the results are in good agreement with the experimental data and finite-difference solutions of the full-potential and Euler equations. Author

**N87-26860*#** Kansas Univ. Center for Research, Inc., Lawrence.
**CALCULATION OF AERODYNAMIC CHARACTERISTICS AT HIGH ANGLES OF ATTACK FOR AIRPLANE CONFIGURATIONS Semiannual Status Report, 1 Aug. 1986 - 31 Jan. 1987**
C. Edward Lan and J. B. Tseng 24 Feb. 1987 25 p
(Grant NAG1-635)
(NASA-CR-180678; NAS 1.26:180678) Avail: NTIS HC A02/MF A01 CSCL 01A

The primary objective is to determine how an airplane configuration should be modeled to predict both longitudinal and lateral aerodynamic characteristics at high angles of attack. A generic fighter model, an F-16 and an F-18 configuration with leading edge flap deflection and an F-106B configuration were investigated. Furthermore, the F-16XL and X-29 configurations were examined. Some calculated results are given. Author

**N87-26861*#** Pennsylvania State Univ., University Park. Dept. of Aerospace Engineering.
**REYNOLDS STRESS CLOSURE IN JET FLOWS USING WAVE MODELS Annual Progress Report**
P. J. Morris 4 May 1987 19 p
(Grant NAG1-657)
(NASA-CR-180558; NAS 1.26:180558) Avail: NTIS HC A02/MF A01 CSCL 01A

Numerical methods were developed that will form the computational part of the turbulence closure scheme. A wave model was developed for the two-dimensional shear layer. This configuration is being used as a test case for the closure schemes. Various numerical schemes were examined to give efficient solutions of the Rayleigh equation for this geometry. These include both spectral and finite difference methods. Secondly, numerical methods are under development to solve the non-separable Rayleigh equation. This solution is required for the closure scheme in more complex geometries. A model problem was used to assist in the algorithm development. Two-dimensional spectral methods and a hybrid spectral/finite difference technique were developed. An analytic solution of the Rayleigh equation for a basic elliptic flow was obtained. This will be used to verify the stability codes developed for arbitrary geometries. Other numerical methods for solving the Rayleigh equation based on the boundary element technique were also examined. These solutions are forming the basis of a model for the shock structure in jets of arbitrary geometry. Author

**N87-26862*#** Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.
**NON-LINEAR UNSTEADY WING THEORY, PART 1. QUASI TWO-DIMENSIONAL BEHAVIOR: AIRFOILS AND SLENDER WINGS Progress Report**
J. E. McCune Jun. 1987 41 p
(Grant NAG1-658)
(NASA-CR-181008; NAS 1.26:181008) Avail: NTIS HC A03/MF A01 CSCL 01A

The initial phases of a study of the large-amplitude unsteady aerodynamics of wings in severe maneuver are reported. The research centers on vortex flows, their initiation at wing surfaces, their subsequent convection, and interaction dynamically with wings and control surfaces. The focus is on 2D and quasi-2D aspects of the problem and features the development of an exact nonlinear unsteady airfoil theory as well as an approach to the crossflow problem for slender wing applications including leading-edge separation. The effective use of interactive on-line computing in quantifying and visualizing the nonsteady effects of severe maneuver is demonstrated. Interactive computational work is now possible, in which a maneuver can be initiated and its effects observed and analyzed immediately. Author

**N87-26863*#** Texas A&M Univ., College Station. Dept. of Aerospace Engineering.
**DEVELOPMENT OF DIRECT-INVERSE 3-D METHODS FOR APPLIED AERODYNAMIC DESIGN AND ANALYSIS Semiannual Progress Report, 1 Jan. - 30 Jun. 1987**
Leland A. Carlson Jul. 1987 30 p
(Grant NAG1-619)
(NASA-CR-181142; NAS 1.26:181142; TAMRF-5373-87-02)
Avail: NTIS HC A03/MF A01 CSCL 01A

A versatile inviscid direct-inverse wing design method and program were developed. Also developed was an additional design strategy option to the program. B.G.

**N87-26864*#** General Dynamics Corp., Fort Worth, Tex.
**A STUDY OF THE EFFECTS OF REYNOLDS NUMBER AND MACH NUMBER ON CONSTANT PRESSURE COEFFICIENT JUMP FOR SHOCK-INDUCED TRAILING-EDGE SEPARATION Final Report**
Atlee M. Cunningham, Jr. and Gregory S. Spragle Washington NASA Aug. 1987 81 p
(Contract NAS1-17955)
(NASA-CR-4090; NAS 1.26:4090) Avail: NTIS HC A05/MF A01 CSCL 01A

The influence of Mach and Reynolds numbers as well as airfoil and planform geometry on the phenomenon of constant shock jump pressure coefficient for conditions of shock induced trailing edge separation (SITES) was studied. It was demonstrated that the phenomenon does exist for a wide variety of two and three dimensional flow cases and that the influence of free stream Mach number was not significant. The influence of Reynolds number was found to be important but was not strong. Airfoil and planform geometric characteristics were found to be very important where the pressure coefficient jump was shown to vary with the sum of: (1) airfoil curvature at the upper surface crest, and (2) camber surface slope at the trailing edge. It was also determined that the onset of SITES could be defined as a function of airfoil geometric parameters and Mach number normal to the leading edge. This onset prediction was shown to predict the angle of onset to within + or - 1 deg accuracy or better for about 90% of the cases studied. Author

**N87-26865*#** Kansas Univ. Center for Research, Inc., Lawrence.
**AN INVESTIGATION OF TIP PLANFORM INFLUENCE ON THE AERODYNAMIC LOAD CHARACTERISTICS OF SEMISPAN, UPSWEPT WING AND WING-TIP**
Johannes M. vanAken Dec. 1986 86 p Previously announced as N86-29766
(Contract NCC2-112)
(NASA-CR-177428; NAS 1.26:177428) Avail: NTIS HC A05/MF A01 CSCL 01A

A semi-span wing, equipped with an interchangeable tip, which was varied in planform and size was examined. Total wing aerodynamic loading was obtained from the wind tunnel scale system. The wing tip was mounted on a separate six-component strain gauge balance, which provided the aerodynamic loads on

the tip. The tests were accomplished in the NASA Ames 7X10-Foot Wind Tunnel at a Mach number of 0.178. The aerodynamic load characteristics of the wing and of the tip were presented with the tip at several incidence angles relative to the wing inboard section. Author

**N87-26866#** Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Engineering Science and Mechanics.
**AERODYNAMIC/DYNAMIC INTERACTION Annual Technical Report**
Dean T. Mook and Ali H. Nayfeh 30 Apr. 1987 80 p
(Grant AF-AFOSR-0158-85)
(AD-A180621; AFOSR-87-0670TR) Avail: NTIS HC A05/MF A01 CSCL 20D

Simulations of wingrock with an additional degree of freedom have been completed and a new technique to simulate the unsteady wake behind an airfoil was developed. An analytical model of the subsonic wingrock phenomenon for a slender wing has been completed and a numerical simulation of the interference between the leading and trailing wings of an X-29 model have been developed further. GRA

**N87-26867#** Aeronautical Research Labs., Melbourne (Australia).
**THE EFFECT OF ROTOR WAKE GEOMETRY VARIATION ON HOVER INDUCED POWER ESTIMATION FOR A UH-1H IROQUOIS HELICOPTER**
K. R. Reddy Oct. 1986 25 p
(AD-A180787; ARL-AERO-TM-384) Avail: NTIS HC A02/MF A01 CSCL 01A

In a simple prescribed rotor wake model for hover developed at ARL, generalized model rotor experimental data are used to position the tip vortices. Parametric studies are conducted to explore the sensitivity of calculated induced power with the positioning of these vortices. Calculated induced power, obtained directly by extrapolating model data to the full-scale case of a UH-1H Iroquois helicopter, is compared with flight data, and the required repositioning of the vortices to match flight data is given. GRA

**N87-26868#** Naval Surface Weapons Center, Silver Spring, Md.
**NOTES ON A PARACHUTE OPENING FORCE ANALYSIS APPLIED TO A VERTICAL TOWARD-THE-EARTH TRAJECTORY Final Report, 1986 - 1987**
William P. Ludtke 28 May 1987 60 p
(AD-A180901; NSWC/TR-87-96) Avail: NTIS HC A04/MF A01 CSCL 01C

Recovery of payloads from high altitude often requires the deployment of parachutes on trajectories that are essentially vertical and toward the Earth. The parachute opening shock force developed by a parachute deployed in this manner exceeds the opening shock force of the same parachute system deployed horzontally at the same altitude and velocity. As the deployment trajectory angle varies from horizontal to vertical, the opening shock force increased to a maximum. Hence, the vertical trajectory has special significance. This report develops an analysis to permit the calculation of opening shock forces in vertical deployment. The validity of the rule of thumb that the vertical deployment opening shock force exceeds the horizontal shock force by one g is tested, and criteria are developed. Examples are used to demonstrate applications of the approach, and a method of calculating the inflation time of Solid Cloth parachutes in vertical fall is developed. GRA

**N87-26869#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**ACTA AERONAUTICA ET ASTRONAUTICA SINICA (SELECTED ARTICLES)**
18 May 1987 34 p Transl. into ENGLISH from Hangkong Xuebao (China), v. 7, no. 2, Apr. 1986 p 205-216
(AD-A181204; FTD-ID(RS)T-0117-86) Avail: NTIS HC A03/MF A01 CSCL 20D

Translated articles from Chinese periodicals are presented. Some topics covered are: Calculations of Steady and Unsteady Transonic Flows Over Airfoils by Monotone Switch; and Applications of Dual Hologram Interferometry to Density Field Determination in Wind Tunnels. GRA

**N87-26870#** Michigan Univ., Ann Arbor. Coll. of Engineering.
**UNSTEADY FLOW IN SUPERSONIC INLET DIFFUSERS Final Technical Report**
T. C. Adamson, Jr. and A. F. Messiter Dec. 1986 9 p
(Grant AF-AFOSR-0327-84)
(AD-A181257; AFOSR-87-0673TR) Avail: NTIS HC A02/MF A01 CSCL 01C

A symmetric supersonic inlet diffuser with flow at supercritical conditions has been analyzed, using both analytical and numerical methods. An equation describing the unsteady motion of the shock passage caused by vibrations in back pressure and/or variations in wall shape has been derived for inviscid flow. Results have been compared with those found using numerical methods both for inviscid and viscous flows fields. GRA

**N87-26871#** Grumman Aerospace Corp., Bethpage, N.Y. Aerosciences Directorate.
**AN INVESTIGATION OF TURBULENCE MECHANISMS IN V/STOL UPWASH FLOW FIELDS Final Report**
Barry L. Gilbert Mar. 1987 72 p
(Contract F49620-85-C-0111)
(AD-A181265; RE-730; AFOSR-87-0603TR) Avail: NTIS HC A04/MF A01 CSCL 01A

Results are presented of an experimental investigation of the abnormally high turbulent mixing layer growth rate characteristics found in the upwash regions of V/STOL flows in ground effect. Three dimensional experimental studies were conducted in a radial wall jet facility. Measurements included velocity components, second - third - fourth moments, and integral and microscale lengths. The upwash formed by the collision of radial wall jets contains the essential characteristics of a radial upwash while decoupling the problem caused by the impinging jets on the ground plane and the recirculation zone. GRA

**N87-26872#** Nielsen Engineering and Research, Inc., Mountain View, Calif.
**A STUDY OF SUPERMANEUVER AERODYNAMICS Final Report, 1 Aug. 1986 - 31 Jan. 1987**
David Nixon and Mohammad Farshchi 13 Feb. 1987 10 p
(Contract F49620-86-C-0071)
(AD-A181490; NEAR-TR-375; AFOSR-87-0626TR) Avail: NTIS HC A02/MF A01 CSCL 01A

An innovative method of examining fluid flow phenomena is described and preliminary results are given. The technique uses a subproblem formulation which examines only those portions of the flow which are of interest. The particular flow examined is that of a stalled airfoil and the objective of the technique is to develop ways of controlling the stall. Both conventional and nonconventional means of stall control have been examined and it is concluded that the subproblem technique is a viable approach for the study of fluid flow phenomena. GRA

**N87-26873#** PEDA Corp., Palo Alto, Calif.
**CLOSING DEVELOPMENTS IN AERODYNAMIC SIMULATION WITH DISJOINT PATCHED MESHES Annual Report, 1 Jun. 1985 - 31 Aug. 1986**
C. K. Lombard, E. Venkatapathy, J. Bardina, N. Nagaraj, and J. Y. Yang 28 Nov. 1986 69 p
(Contract F49620-85-C-0081)
(AD-A181512; AFOSR-87-0782TR) Avail: NTIS HC A04/MF A01 CSCL 20D

The research is aimed at providing computational tools and procedures as the building blocks to permit efficient solution and high resolution capture of flow structure in gasdynamic problems of realistically complex geometries. It has yielded a comparatively simple algebraic procedure for constructing two and three dimensional geometry fitted base level composite meshes in

quadrilateral patches. The method provides complete control of coordinate distribution and gradient on all patch boundaries which may include slow discontinuities. A robust upwind implicit method (CSCM) was the basis to solve the multidimensional pseudo time dependent Euler or compressible Navier-Stokes equations. Research into solution algorithms for that upwind method has yielded a more robust diagonally dominant (DDADI) approximate factorization that subsequently led to a family of rapidly convergent and data storage and management efficient relaxation schemes in two and three space dimensions. Results of tests with reflecting shock capture on overset adaptively refined mesh patches in a 2-D supersonic inlet problem show for comparable accuracy a savings of about an order of magnitude in mesh points relative to uniform mesh refinement. GRA

**N87-26874*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

**SUBSONIC LONGITUDINAL AND LATERAL-DIRECTIONAL CHARACTERISTICS OF A FORWARD-SWEPT-WING FIGHTER CONFIGURATION AT ANGLES OF ATTACK UP TO 47 DEG**

Michael J. Mann, Jarrett K. Huffman, and Charles H. Fox, Jr. Sep. 1987 103 p

(NASA-TP-2727; L-16206; NAS 1.60:2727) Avail: NTIS HC A06/MF A01 CSCL 01A

Subsonic lateral-direction and longitudinal characteristics of a forward-swept-wing fighter configuration were examined in wind-tunnel tests at Mach numbers of 0.2 and 0.5 for angles of attack from -7 to 47 deg. and over a sideslip range of +/- 15 deg. The effects of a canard, strakes, vertical tail, and leading- and trailing-edge flaps are examined. The canard and strakes both reduce asymmetric moments and side forces at zero sideslip for angles of attack up to about 30 deg. The canard has a small influence on lateral-directional stability; however, strakes produce a substantial reduction in lateral stability for angles of attack greater than about 20 deg. The vertical tail improves directional stability for angles of attack up to 30 deg. Deflection of the leading-edge flap to 20 deg. at high angles of attack on the strake and canard configurations degrades lateral and directional stability. Deflection of the trailing-edge flap to 20 deg. on the canard configuration generally increases lateral and directional stability at high angles of attack. Leading- and trailing-edge flaps on the wing-body and canard configurations are effective for increased lift only for angles of attack up to about 40 deg. The leading-edge flap remains effective on the strake configuration over the entire angle-of-attack range tested. Author

**N87-26875*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**AERODYNAMIC CHARACTERISTICS OF THE MODIFIED 40- BY 80-FOOT WIND TUNNEL AS MEASURED IN A 1/50TH-SCALE MODEL**

Brian E. Smith and Tim Naumowicz Aug. 1987 56 p

(NASA-TM-88336; A-86329; NAS 1.15:88336) Avail: NTIS HC A04/MF A01 CSCL 01A

The aerodynamic characteristics of the 40- by 80-Foot Wind Tunnel at Ames Research Center were measured by using a 1/50th-scale facility. The model was configured to closely simulate the features of the full-scale facility when it became operational in 1986. The items measured include the aerodynamic effects due to changes in the total-pressure-loss characteristics of the intake and exhaust openings of the air-exchange system, total-pressure distributions in the flow field at locations around the wind tunnel circuit, the locations of the maximum total-pressure contours, and the aerodynamic changes caused by the installation of the acoustic barrier in the southwest corner of the wind tunnel. The model tests reveal the changes in the aerodynamic performance of the 1986 version of the 40- by 80-Foot Wind Tunnel compared with the performance of the 1982 configuration. Author

**N87-26876*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

**SATELLITE SITUATION REPORT, VOLUME 25, NUMBER 3**

31 Dec. 1985 298 p

(NASA-TM-89367; NAS 1.15:89367) Avail: NTIS HC A13/MF A01 CSCL 01A

A listing is given of those satellites currently in orbit and those that have previously orbited the Earth. Additionally, platforms, rocket bodies and debris are listed. Author

**N87-26877*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

**OPERATIONAL PERFORMANCE OF VAPOR-SCREEN SYSTEMS FOR IN-FLIGHT VISUALIZATION OF LEADING-EDGE VORTICES ON THE F-106B AIRCRAFT**

John E. Lamar, Philip W. Brown, Robert A. Bruce, Joseph D. Pride, Jr., Ronald H. Smith, and Thomas D. Johnson, Jr. (PRC Kentron, Inc., Hampton, Va.) Sep. 1987 84 p

(NASA-TM-4004; L-16306; NAS 1.15:4004) Avail: NTIS HC A05/MF A01 CSCL 01A

A flight research program was undertaken at the NASA Langley Research Center to apply the vapor-screen technique, widely used in wind tunnels, to an aircraft. The purpose was to obtain qualitative and quantitative information about near-field vortex flows above the wings of fighter aircraft and ascertain the effects of Reynolds and Mach numbers over the angle-of-attack range. The hardware for the systems required for flight application of the vapor-screen technique was successfully developed and integrated. Details of each system, its operational performance on the F-106B aircraft, and pertinent aircraft and environmental data collected are presented. Author

**N87-26878*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

**WIND-TUNNEL EVALUATION OF AN ADVANCED MAIN-ROTOR BLADE DESIGN FOR A UTILITY-CLASS HELICOPTER**

William T. Yeager, Jr., Wayne R. Mantay, Matthew L. Wilbur, Robert G. Cramer, Jr., and Jeffrey D. Singleton Sep. 1987 40 p Prepared in cooperation with Army Aviation Research and Development Command, Hampton, Va.

(DA Proj. 1L1-62209-AH-76B)

(NASA-TM-89129; L-16260; NAS 1.15:89129; AVSCOM-TM-87-B-8) Avail: NTIS HC A03/MF A01 CSCL 01A

An investigation was conducted in the Langley Transonic Dynamics Tunnel to evaluate differences between an existing utility-class main-rotor blade and an advanced-design main-rotor blade. The two rotor blade designs were compared with regard to rotor performance oscillatory pitch-link loads, and 4-per-rev vertical fixed-system loads. Tests were conducted in hover and over a range of simulated full-scale gross weights and density altitude conditions at advance ratios from 0.15 to 0.40. Results indicate that the advanced blade design offers performance improvements over the baseline blade in both hover and forward flight. Pitch-link oscillatory loads for the baseline rotor were more sensitive to the test conditions than those of the advanced rotor. The 4-per-rev vertical fixed-system load produced by the advanced blade was larger than that produced by the baseline blade at all test conditions. Author

**N87-26879*#** Remtech, Inc., Huntsville, Ala.

**INVESTIGATION OF HYPERSONIC RAREFIED FLOW ON A SPHERICAL NOSE OF THE AOTV Final Report**

Amolak C. Jain and G. Hamilton Woods 20 Jul. 1987 99 p (Contract NAS8-37305)

(NASA-CR-179153; NAS 1.26:179153; RTR-175-01) Avail: NTIS HC A05/MF A01 CSCL 01A

The Navier-Stokes (NS) equations were integrated numerically for investigating the flow characteristics on the forepart of the spherical nose of a space vehicle such as the AOTV or AFE by a modified Accelerated Successive Replacement (ASR) scheme under hypersonic rarefied conditions. Technical feasibility of the mathematical approach was demonstrated by computing the flowfield on a spherical nose under conditions that the AFE encounters at times t = 15 and 20 seconds after its reentry into the atmosphere. Local similar solutions for the merged layer flow

along the stagnation line of the sphere were developed. These are correct to the same degree of accuracy as the NS equations. These solutions provided stagnation line boundary conditions for the domain of integration on the spherical noise. Also, a parametric study of the stagnation line solution was made with a view to understand the flow characteristics in tunnels with different ambient fluids. Analytical expressions for surface slip temperature, jump conditions, and concentration level in the presence of the real gas effects at the top of the Knudsen layer were derived and used to calculate the stagnation line flowfield with nonequilibrium dissociation and ionization. A number of graphics were drawn to illustrate the basic physics of the flowfields. The present analysis can be extended to include real gas effects and to bodies of arbitrary shapes. It can further provide boundary conditions for integrating the NS equations in the near wake region. Author

**N87-26880*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**MULTIGRID SOLUTION OF THE EULER EQUATIONS ON UNSTRUCTURED AND ADAPTIVE MESHES Final Report**
Dimitri Mavriplis and Antony Jameson (Princeton Univ., N. J.) Jul. 1987 21 p Submitted for publication
(Contract NAS1-18107)
(NASA-CR-178346; ICASE-87-53; NAS 1.26:178346) Avail: NTIS HC A02/MF A01 CSCL 01A

A multigrid algorithm has been developed for solving the steady-state Euler equations in two dimensions on unstructured triangular meshes. The method assumes the various coarse and fine grids of the multigrid sequence to be independent of one another, thus decoupling the grid generation procedure from the multigrid algorithm. The transfer of variables between the various meshes employs a tree-search algorithm which rapidly identifies regions of overlap between coarse and fine grid cells. Finer meshes are obtained either by regenerating new globally refined meshes, or by adaptively refining the previous coarser mesh. For both cases, the observed convergence rates are comparable to those obtained with structured multigrid Euler solvers. The adaptively generated meshes are shown to produce solutions of higher accuracy with fewer mesh points. Author

**N87-26881#** Leicester Univ. (England). Dept. of Engineering.
**THE AERODYNAMICS OF PARACHUTES**
D. J. Cockrell and A. D. Young, ed. Jul. 1987 81 p Sponsored by AGARD, Neuilly-sur-Seine, France
(AGARD-AG-295; ISBN-92-835-0422-4) Copyright Avail: NTIS HC A05/MF A01

This AGARD report discusses the principal aerodynamic characteristics of parachutes and the factors which affect them. It is anticipated that its main readers will be recent engineering graduates entering research establishments, parachute companies or related industries so some appreciation of basic mechanics, the principles of computing and elementary fluid dynamics on the part of the reader has been assumed. Its contents include Steady-State and Unsteady Aerodynamics, Parachute Deployment and Inflation, Experimental Investigations, Methods of analysis, Extraterrestrial Parachute Applications, and some suggestions for future research. Author

**N87-26882#** Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Direction Scientifique de la Resistance des Structures.
**COMPUTATION OF GENERALIZED AERODYNAMIC FORCES OVER AN ENTIRE AIRCRAFT, TAKING INTO ACCOUNT THE SUBSONIC INTERACTIONS BY MEANS OF THE VELOCITY POTENTIAL METHOD [CALCUL DES FORCES AERODYNAMIQUES GENERALISEES FUR UN AVION COMPLET EN TENANT COMPTE DES INTERACTIONS EN SUBSONIQUE PAR LA METHODE DUE POTENTIEL DE VITESSE]**
J. P. Grisval Nov. 1986 39 p In FRENCH
(Contract STPA-85-95-004)
(ONERA-RT-26/3064-RY-052-R; ETN-87-90123) Avail: NTIS HC A03/MF A01

A computer program for aerodynamic forces on aircraft is presented. The numerical analysis in the subsonic domain is based on the solution of integral equations relating the velocity potential to the structure modes. Program performance on a CRAY-1 computer is detailed (computation time and memory utilization for each case). ESA

**N87-26883*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**AN EXPERIMENTAL INVESTIGATION OF AN ADVANCED TURBOPROP INSTALLATION ON A SWEPT WING AT SUBSONIC AND TRANSONIC SPEEDS**
John R. Carlson and Odis C. Pendergraft, Jr. Sep. 1987 242 p
(NASA-TP-2729; L-16043; NAS 1.60:2729) Avail: NTIS HC A11/MF A01 CSCL 01A

An investigation was conducted in the Langley 16-Foot Transonic Tunnel to determine the effects of a turboprop-nacelle installation on the pressure distributions over a swept, supercritical wing. The tests were conducted at Mach numbers from 0.20 to 0.80, at angles of attack from 0 to 5 degrees, nacelle nozzle pressure ratios from 1.0 to 1.6, and at propeller tip speeds from 700 to 800 ft/sec. The results of this study indicate that the turboprop nacelle interference, with and without power, on a swept wing is greater on the inboard wing panel than on the outboard wing panel. The over-the-wing nacelle installation with the propeller upwash on the inboard panel had flow separation problems at a Mach number of 0.80. No severe flow separation problems appear to exist for either propeller rotation direction for the under-the-wing nacelle installation. The local flow disturbances caused by the under-the-wing nacelle installation were in general less severe than for the over-the-wing nacelle installation. Author

# 03 AIR TRANSPORTATION AND SAFETY

Includes passenger and cargo air transport operations; and aircraft accidents.

For related information see also *16 Space Transportation* and *85 Urban Technology and Transportation.*

**N87-26884#** Boeing Military Airplane Development, Seattle, Wash.
**EFFECTS OF AIRCRAFT ENGINE BLEED AIR DUCT FAILURES ON SURROUNDING AIRCRAFT STRUCTURE Interim Report, 21 Mar. - 1 May 1986**
Alan M. Johnson Apr. 1987 122 p
(Contract F33615-84-C-2431)
(AD-A181071; D180-29965-1; AFWAL-TR-87-2004) Avail: NTIS HC A06/MF A01 CSCL 21E

Simulated bleed air impingement tests were conducted to explore the possibility that an engine bleed air leak contributed to the loss of an F-16 aircraft. A data base of the results of hot engine bleed air impinging on engine compartment walls was established for selected aircraft aluminum materials. Testing indicated the specific F-16 conditions could not have caused panel burnthrough; however, substituting other conditions did result in panel burnthrough. The results provide information which will assist in future mishap investigations. GRA

**N87-26885#** Naval Postgraduate School, Monterey, Calif.
**COST ANALYSIS FOR AIRCRAFT SYSTEM TEST AND EVALUATION: EMPIRICAL SURVEY DATA STRUCTURING AND PARAMETRIC MODELING, VOLUME 2 M.S. Thesis**
William J. Foster and Walter J. Moore, Jr. Mar. 1987 256 p
(AD-A181466) Avail: NTIS HC A12/MF A01 CSCL 05C

There is an increasing requirement from high levels within the Government that the Navy's aircraft cost estimators and analysts provide explicit estimates for the sub-elements of Aircraft System Test and Evaluation (AST and E) efforts. The data required to produce more accurate and detailed estimates represent lower levels in the Aircraft Work Breakdown Structure (WBS) than previously available. This is a two volume thesis. Beginning in this

document (Volume 2), a relational data base system is introduced to more easily evaluate AST and E cost elements and physical/performance characteristics. A Contractor Flight Test cost estimating relationship (CER) is developed through step-wise multiple regression analysis of data gathered from Defense Contractors and Naval Air Systems Command (NAVAIR). GRA

**N87-26886#** Science and Engineering Associates, Inc., Seattle, Wash.
**CREW ESCAPE CAPSULE TO AIRFRAME LATCH/DISCONNECT MECHANISMS Final Report, Jun. 1986 - Jan. 1987**
William S. Rippi and C. G. Elcock Jan. 1987 97 p
(Contract F33615-86-C-3421)
(AD-A181565; AFWAL-TR-87-3013) Avail: NTIS HC A05/MF A01 CSCL 01C

Ejection seats still have performance shortfalls in the high speed regime typical of jet combat operations, i.e., at speeds above 450 knots. An alternative approach, operational in the F-111 aircraft, is that of the jettisonable crew escape capsule. Although providing improved aircrew survivability during high speed ejection, the F-111 capsule design is maintenance intensive. The capsule-to-airframe interface involves pyrotechnic devices which destroy the interface upon ejection. Therefore, inspection and maintenance procedures require extensive hardware disassembly. To reduce the complexity of these procedures, simplify the structural interface, reduce life cycle costs, and facilitate removal and replacement of the capsule at the operational level, a non-destructive, mechanical latch interface has been proposed. Described are the development of several mechanical latch concepts for use in proposed escape capsule/airframe interface. An evaluation of these concepts has produced a preferred design concept recommended for development and prototype demonstration. GRA

**N87-26887#** National Oceanic and Atmospheric Administration, Boulder, Colo. Environmental Research Labs.
**CRASH OF DELTA FLIGHT 191 AT DALLAS-FORT WORTH INTERNATIONAL AIRPORT ON 2 AUGUST 1985: MULTISCALE ANALYSIS OF WEATHER CONDITIONS**
F. Caracena, R. Ortiz, and J. A. Augustine Dec. 1986 38 p
(PB87-183455; NOAA-TR-ERL-430; ESG-2) Avail: NTIS HC A03/MF A01 CSCL 01C

The third microburst-related disaster in the decade since 1976 occurred when Delta Flight 191 cracked while on the landing approach to Runway 17L at Dallas-Fort Worth International Airport (DFW) on 2 August 1985. The microburst-producing storm occurred almost in the center of a large-scale high-pressure almost in the center of a large-scale high-pressure area that extended through a deep layer of the troposphere and was interrupted only near the surface by a thermal low-pressure area in combination with a low-pressure trough that was associated with a weak frontal boundary. A computer-generated analysis of the pattern of deep tropospheric forcing reveals that a high lapse rate in the lower troposphere was generated by a pattern of vertical motion that tended to stretch the atmospheric column. The very weak front that lingered over DFW, and resurged southward at about the time of the accident, lifted the shallow, moisture surface layer, triggering a line of discrete thunderstorm, one of which, situated along the approach to Runway 17L, produced the microburst that brought down Delta 191. In this case, a digital flight recorder has provided data from which the highest resolution analysis of microburst winds was possible. The analysis showed that the wind field within a microburst has a very complex structure with imbedded smaller scale vortices that inflict serious control problems on a penetrating aircraft, to compound the hazard of severe wind shear. GRA

**N87-26888#** National Transportation Safety Board, Washington, D. C. Bureau of Field Operations.
**AIRCRAFT ACCIDENT REPORTS. BRIEF FORMAT, US CIVIL AND FOREIGN AVIATION, ISSUE NUMBER 16, 1985 ACCIDENTS**
3 Feb. 1987 350 p
(PB87-916902; NTSB/AAB-87/02) Avail: NTIS HC A15/MF A01 CSCL 01C

The publication contains selected aircraft accident reports in brief format occurring in U.S. civil and foreign aviation operations during calendar years 1982 to 1985. Approximately 300 general aviation and air carrier accidents contained in the publication representing a random selection. The publication is issued irregularly, normally eighteen times each year. The brief format represents the facts, conditions, circumstances and probable cause(s) for each accident. GRA

**N87-26889#** National Transportation Safety Board, Washington, D. C. Bureau of Accident Investigation.
**AIRCRAFT ACCIDENT REPORT: COLLISION OF AERONAVES DE MEXICO, S.A., MCDONNELL DOUGLAS DC-9-32, XA-JED AND PIPER PA-28-181, N4891F, CERRITOS, CALIFORNIA, AUGUST 31, 1986**
7 Jul. 1987 115 p
(PB87-910409; NTSB/AAR-87/07) Avail: NTIS HC A06/MF A01 CSCL 01C

On August 31, 1986, about 1152 Pacific daylight time, Aeronaves de Mexico, S.A., flight 498, a DC-9-32, Mexican registration XA-JED, and a Piper PA-28-181, U.S. registration N4891F, collided over Cerritos, California. The National Transportation Safety Board determined that the probable cause of the accident was the limitations of the air traffic control system to provide collision protection, through both air traffic control procedures and automated redundancy. Factors contributing to the accident were: (1) the inadvertent and unauthorized entry of PA-28 into the Los Angeles Terminal Control Area, and (2) the limitations of the see and avoid concept to ensure traffic separation under the conditions of the conflict. Author

# 04 AIRCRAFT COMMUNICATIONS AND NAVIGATION

Includes digital and voice communication with aircraft; air navigation systems (satellite and ground based); and air traffic control.

For related information see also *17 Space Communications, Spacecraft Communications, Command and Tracking* and *Communications and Radar.*

**N87-26890#** Naval Surface Weapons Center, Dahlgren, Va.
**GLOBAL POSITIONING SYSTEM (GPS) ABSOLUTE POSITION OF TRIDENT II (D5X) THEODOLITE PEDESTAL 187.5 Final Report**
Stanly L. Meyerhoff and Bruce R. Hermann Dec. 1986 17 p
(AD-A181114; NSWC/TR-86-315) Avail: NTIS HC A02/MF A01 CSCL 17G

Results of the positioning of the Trident II Launch Pad 46A from GPS tracking data are presented. For 3 days, data were collected with the Texas Instruments 4100 Geodetic Receiver (TIGER) System, and the position of Theodolite Pedestal 187.5 was determined for each of the 3 days of tracking by using post-fit GPS ephemerides. The position solutions differed from the Defense Mapping Agency (DMA) land survey position by 1.3, 1.3, and 1.9 meters root sum squared (RSS) for 16, 17, and 18 June 1986, respectively. GRA

**N87-26891#** Defense Communications Engineering Center, Reston, Va.
**APPLICATION OF THE NAVSTAR GLOBAL POSITIONING SYSTEM (GPS) TO THE NETWORK SYNCHRONIZATION OF THE DCS (DEFENSE COMMUNICATIONS SYSTEM)**
Thomas L. McCrickard, III 1 Mar. 1987 47 p
(AD-A181457; DCEC-TN-1-87) Avail: NTIS HC A03/MF A01 CSCL 17G

This publication describes the proposed network synchronization capability for the near-term Defense Communications System (DCS), and in particular the methodology for integrating this capability with the evolving NAVSTAR Global

Positioning System (GPS). A detailed description of the GPS is provided as well as a discussion as to how it might be applied in the DCS. Finally, a description is given for some of the available, commercial, off-the-shelf, GPS receivers. GRA

**N87-26892#** Allied-Bendix Corp., Baltimore, Md. Communications Div.
**TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM (TCAS-3) Final Engineering Report**
E. A. Hecht and J. E. Reed Apr. 1987 89 p
(Contract DTFA01-82-C-10019)
(BCD-TR-157; DOT/FAA/PM-87/14) Avail: NTIS HC A05/MF A01

The Task-1 contract on TCAS-11 produced a system concept and a design specification that show the 743 Aircraft L. A. Basin Model with peak densities well in excess of 0.4 aircraft per square nautical mile can be met. This Task-2 contract is for the design, construction, and testing of two enhanced TCAS-11 (TCAS-111) Engineering units. A description of the TCAS-111 engineering model is presented along with results from various flight tests of the system. System no. 1 has been installed on the FAA's 727 since 1983. Testing shows that angular accuracies in the order of 1 to 2 degrees are feasible and that Horizontal Resolution Advisories can be given on intruders. System no. 2 was delivered to the FAA Technical Center and installed on a Convair 580. Both systems will continue to fly as test beds for TCAS 111. Author

**N87-26893*#** McDonnell-Douglas Corp., Long Beach, Calif.
**SIMULATION OF AUTOMATIC PRECISION DEPARTURES AND MISSED APPROACHES USING THE MICROWAVE LANDING SYSTEM**
J. B. Feather Jul. 1987 66 p
(Contract NAS1-16202)
(NASA-CR-178312; NAS 1.26:178312) Avail: NTIS HC A04/MF A01 CSCL 17G

Results of simulated precision departures and missed approaches using MLS guidance concepts are presented. The study was conducted under the Terminal Configured Vehicle (TCV) Program, and is an extension of previous work by DAC under the Advanced Transport Operating System (ATOPS) Technology Studies Program. The study model included simulation of an MD-80 aircraft, an autopilot, and a MLS guidance computer that provided lateral and vertical steering commands. Precision departures were evaluated using a noise abatement procedure. Several curved path departures were simulated with MLS noise and under various environmental conditions. Missed approaches were considered for the same runway, where lateral MLS guidance maintained the aircraft along the extended runway centerline. In both the departures and the missed approach cases, pitch autopilot takeoff and go-around modes of operation were used in conjunction with MLS lateral guidance. Author

**N87-26894#** General Accounting Office, Washington, D. C. Resources Communication and Economic Development Div.
**AIR TRAFFIC SYSTEM: PILOT PROGRAM TO CONTRACT OUT MAINTENANCE AT SELECTED FACILITIES**
Apr. 1987 35 p
(PB87-186607; GAO/RCED-87-104BR; B-225200) Avail: NTIS HC A03/MF A01 CSCL 17G

This briefing report reviews the Federal Aviation Administration's (FAA) proposed pilot test program to contract out for maintenance at selected air traffic control facilities. The report provides information on pilot test design and status; evaluates the pilot test's potential for affecting air traffic safety and efficiency; determines if the proposed pilot program would adequately test a contractor's ability to independently perform the maintenance function; and assess FAA efforts to control and estimate pilot test costs. It was not within the scope of the review to evaluate the appropriateness, from a policy standpoint, of contracting out for maintenance in lieu of relying on the federal work force. GRA

# 05 AIRCRAFT DESIGN, TESTING AND PERFORMANCE

Includes aircraft simulation technology.

For related information see also *18 Spacecraft Design, Testing and Performance* and *39 Structural Mechanics*.For land transportation vehicles see *85 Urban Technology and Transportation.*

**N87-26895*#** Texas A&M Univ., College Station. Dept. of Aerospace Engineering
**DEVELOPMENT OF DIRECT-INVERSE 3-D METHOD FOR APPLIED AERODYNAMIC DESIGN AND ANALYSIS Semiannual Progress Report, 1 Jul. - 31 Dec. 1986**
Leland A. Carlson Jan. 1987 51 p
(Grant NAG1-619)
(NASA-CR-180646; NAS 1.26:180646; TAMRF-5373-87-01)
Avail: NTIS HC A04/MF A01 CSCL 01C

The primary tasks performed were the continued development of inverse design procedures for the TAWFIVE code, the development of corresponding relofting and trailing edge closure procedures, and the testing of the methods for a variety of cases. The period from July 1, 1986 through December 31, 1986 is covered. Author

**N87-26896** ESDU International Ltd., London (England).
**INTRODUCTION TO INSTALLATION EFFECTS ON THRUST AND DRAG FOR PROPELLER-DRIVEN AIRCRAFT**
Jun. 1985 24 p
(ESDU-85015; ISBN-0-85679-521-6; ISSN-0141-397X) Avail: ESDU

ESDU 85015 first explains the definitions of propeller thrust and efficiency in free air, discussing the contributions to losses from blade profile drag and induced effects, the latter split further into those arising from axial and swirl velocities. The influence of propeller design on free air efficiency is considered. Then the effect of propeller installation, in tractor or pusher configuration, on propeller thrust and airframe drag is discussed for propeller-nacelle and propeller-nacelle-wing combinations, and the different thrust definitions commonly applied to the tractor propeller-nacelle situation in the US and the UK are explained. The interference effects due to cooling air inlets, and turbine engine exhaust jets, are also considered. The simple axial momentum theory is presented and used to establish the axial variation of the axial velocity, streamtube diameter and static pressure for a practical range of thrust coefficients. A thrust/drag accounting framework is provided in ESDU 85017. ESDU

**N87-26897** ESDU International Ltd., London (England).
**THRUST AND DRAG ACCOUNTING FOR PROPELLER/AIR-FRAME INTERACTION**
Nov. 1985 15 p
(ESDU-85017; ISBN-0-85679-523-2; ISSN-0141-397X) Avail: ESDU

ESDU 85017 sets up an accounting framework for the split between thrust and drag for propeller-driven aircraft. It is assumed that free-air thrust is known either from calculations or from tunnel measurements of minimum-body, or net, thrust. The corrections to free-air thrust, due to blockage and induced effects, and to propeller-off airframe drag, due to pressure gradients and increased velocities in the streamtube, are tabulated to form a check list of all interference contributions. The use of the interference corrections in deducing the excess thrust is explained, and differences between the current approach in the US and the UK are highlighted. Discussion of the various propeller-airframe interference effects will be found in ESDU 85015. ESDU

**N87-26898#** Army Aviation Engineering Flight Activity, Edwards AFB, Calif.
**FLIGHT CHARACTERISTICS TEST OF THE UH-60A WITH TAIL BOOM MOUNTED STRAKE Final Report, 11 - 19 Aug. 1986**
Roy A. Lockwood, William A. Kelly, and Randall W. Carson Oct. 1986 31 p

(AD-A180791; USAAEFA-85-07) Avail: NTIS HC A03/MF A01 CSCL 01C

The effect of a tail-boom mounted strake on the performance and handling qualities of the UH-60A helicopter was evaluated. A total of 2.0 productive flight hours were flown between 11 to 19 Aug. 1986. The UH-60A helicopter's overall performance in hover and sideward flight to 45 knots true airspeed (KTAS) is essentially unchanged by the strake installation. There was an overall effect of the strake installation on the UH-60A's flight control margins, except for a slight reduction in right cyclic control displacement (increase in control margin) required in right sideward flight. There was a minor improvement in longitudinal cyclic pilot workload in left and right sideward flight to 15 KTAS. The pilot did not detect a significant difference in flying qualities with the strake installed. This test reflected little change with the strake installed. Previous US Army Aviation Engineering Flight Activity performance and flying qualities evaluations of the UH-60A without a tail boom mounted strake have found no control margin or power required problems with sideward flight. Consequently, no further strake testing should be conducted on the UH-60A helicopter. The UH-1H helicopter, which has a documented problem with tail rotor control margins during hover and sideward flight, should be considered a candidate for a tail boom strake evaluation. GRA

**N87-26899#** McDonnell Aircraft Co., St. Louis, Mo.

**FLIGHT WORTHINESS OF FIRE RESISTANT HYDRAULIC SYSTEMS. VOLUME 2: COMPONENT AND ENDURANCE TESTING Final Report, Jan. 1981 - Dec. 1986**

J. R. Jeffery, S. E. Pehowski, N. J. Pierce, J. A. Wieldt, and R. E. Young 30 Dec. 1986 263 p

(Contract F33615-80-C-2074)

(AD-A180865; AFWAL-TR-84-2085-Vol-2) Avail: NTIS HC A12/MF A01 CSCL 13G

This document is the second of two volumes which make up the Flight Worthiness of Fire Resistant Hydraulic Systems final report. This document reports efforts involved in component procurement, analysis, qualification testing, the 750-hour endurance test, analytical model verification, and results of the teardown are included. The follow-on contract to perform a study of pump pulsation attenuation and actuator stiffness are reported in this volume. Components procured for the endurance tests setup included an 8000 psi hydraulic pump, servoactuator, utility actuator, filters, relief and check valves, and various required seals. The results of the endurance test show that 8000 psi CTFE hydraulic systems are a practical and feasible approach for next generation aircraft design. Two areas of concern, pump pulsations, and actuator stiffness were studied. Acceptable candidate solutions for both topics are included. GRA

**N87-26900#** Army Aviation Engineering Flight Activity, Edwards AFB, Calif.

**EVALUATION OF THE OV-1D AIRCRAFT WITH THE YT53-L-704 ENGINE AND RUDDER AUGMENTATION SYSTEM, PHASE 2 Final Report, 16 Dec. 1985 - 7 Mar. 1986**

George M. Yamakawa, Joseph C. Miess, Jeffrey L. Linehan, and Joseph L. Piotrowski Nov. 1986 106 p

(AD-A180966; USAAEFA-85-17) Avail: NTIS HC A06/MF A01 CSCL 21E

A 3-phase evaluation of the OV-1D aircraft with increased power YT53-L-704 engines and a prototype rudder augmentation system (RAS) installation was performed. Phase 1 involved engine build-up initial engine and RAS intallation, engine/propeller/airframe compatibility test, and initial flight tests. The Louvered Scarfed Shroud Suppressor (LSSS) system was removed following a high power ground run due to high engine nacelle temperatures which caused extensive damage to the fire shield and seal. All subsequent tests were conducted without LSSS installed. In the Phase 2A tests, the directional control system as designed and modified with RAS was unsatisfactory. Phase 2B required 30.5 flight hours to complete. No problem of YT53-L-704 engine/OV-1D airframe compatibliity were identified with the exception of the LSSS high nacelle temperature. With YT53-L-704 engines installed, the OV-1D takeoff and single-engine climb performance were significantly improved. Dual-engine level flight range and endurance decreased approximately 5 and 4% respectively. Handling qualities of the OV-1D were essentially unchanged at the high powers attainable with the Y53-L-704. GRA

**N87-26901#** Aeronautical Research Labs., Melbourne (Australia).

**VALIDATION OF THE ARL (AERONAUTICAL RESEARCH LABORATORIES) MATHEMATICAL MODEL OF THE SEA KING MK 50 HELICOPTER Aerodynamics Technical Memorandum**

M. J. Williams and A. M. Arney Nov. 1986 50 p

(AD-A181314; ARL-AERO-TM-383) Copyright Avail: NTIS HC A03/MF A01 CSCL 01C

A mathematical model of the Sea King Mk 50 helicopter has been developed at ARL to allow prediction of the aircraft flight behavior for a wide range of specified conditions. Validation of the model has been performed by successive comparisons with flight data and model adjustment to achieve acceptable overall agreement. Such comparisons have been made for trimmed flight, dynamic responses to control inputs and automatic transitions associated with the ASW role. Some remaining deficiencies in the model could be addressed by modifications tailored to a specific application. GRA

**N87-26902#** Naval Postgraduate School, Monterey, Calif.

**MICROCOMPUTER SOFTWARE SUPPORT FOR CLASSES IN AIRCRAFT CONCEPTUAL DESIGN M.S. Thesis**

Michael L. Cramer Mar. 1987 92 p

(AD-A181450) Avail: NTIS HC A05/MF A01 CSCL 05I

The conceptual phase of aircraft design determines the general size and configuration of an aircraft. Many calculations are performed in assessing the optimum parameters. The calculations are often lengthy and iterative in nature and are thus highly appropriate for computer programming. This thesis develops a computer program to enhance learning about design by performing calculations for aircraft conceptual design which follow hand calculation methods. It is intended to be used in the aircraft design course taught by the Department of Aeronautics at the Naval Postgraduate School, Monterey (Calif.). The computer program written for this thesis is divided into ten chapters, which are addressed through a commom menu called the Chapter Selection Program: (1) Introductions; (2) Preliminary Estimate of Take-off Weight; (3) Meeting Performance Requirements; (4) Aspect Ratio Optimization; (5) Wing Geometry Design; (6) Estimating Fuselage Length; (7) Tail Design; (8) Determining Structural Weights (WS); (9) Refined Estimate of WTO Using WS; and (10) End Session. GRA

**N87-26903#** Aeronautical Research Labs., Melbourne (Australia).

**AN INVESTIGATION OF SOME SIMPLE MODELS FOR THE F/A-18 FLIGHT DYNAMICS**

M. Iob Jan. 1987 29 p

(AD-A181638; ARL/SYS-TM-90) Avail: NTIS HC A03/MF A01 CSCL 01A

Simplified mathematical models for both closed loop and open loop F/A-18 flight dynamics are presented. In each case a description of the model is given followed by a comparison of results produced with those published in the literature. Agreement is very good for the longitudinal dynamics and reasonable for the lateral dynamics. GRA

**N87-26904#** Royal Aircraft Establishment, Farnborough (England).

**A METHOD FOR THE MANUFACTURE OF MODEL HELICOPTER ROTOR BLADES WITH TORSIONAL STIFFNESS REPRESENTATIVE OF FULL SCALE**

A. R. Lee Nov. 1985 46 p

(RAE-TR-85094; RAE-Mat/Struct-149; BR99422; ETN-87-90090) Copyright Avail: NTIS HC A03/MF A01

A construction method which allows torsional stiffness of model rotor blades to be reduced to a level representative of full scale

was developed. The blades consist of a CFRP spar, surrounded by a rigid foam aerodynamic fairing, covered in a thin glass fiber reinforced plastic skin. The reasoning behind each stage of development is discussed, and the manufacturing technique is described. This uses a twisted mold to manufacture the spar, and an aluminum alloy female mold to apply the glass fiber reinforced plastic skins. ESA

**N87-26905** Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
**ELEMENTARY DATA ANALYSIS OF MEASUREMENTS IN NONSTEADY LONGITUDINAL AND LATERAL FLIGHT TEST MANEUVERS**
C. G. Kranenburg, P. deLange, and J. A. Mulder 1986 133 p
(VTH-LR-409; ISBN-90-6275-239-X; B8650034; ETN-87-90193)
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Flight tests in nonsteady, symmetrical, and asymmetrical flight were carried out to prove the validity of a method for the simultaneous measurement of performance and stability and control characteristics. Analog dc voltage output signals of transducers or signal conditioners in the instrumentation system are passed through low-pass filters, fed to a multiplexer, and converted to a digital signal. The parallel digital output of the analog to digital converter is serialized and recorded on magnetic tape together with administrative data. After the flight the aircraft tape information is passed, in parallel format, to a digital computer. This computer produces a nine-track IBM-compatible tape suitable for further data reduction. Translation of the recorded voltages into the physical values is described. ESA

**N87-26906*#** National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
**PRELIMINARY FLIGHT ASSESSMENT OF THE X-29A ADVANCED TECHNOLOGY DEMONSTRATOR**
John W. Hicks and Neil W. Matheny Sep. 1987 15 p Presented at the AIAA/AHS/ASEE Aircraft Design, Systems and Operations Meeting, St. Louis, Mo., 13-16 Sep. 1987
(NASA-TM-100407; H-1427; NAS 1.15:100407; AIAA-87-2949)
Avail: NTIS HC A02/MF A01 CSCL 01C

Several new technologies integrated on the X-29A advanced technology demonstrator are being evaluated for the next generation of fighter aircraft. Some of the most noteworthy ones are the forward-swept wing, digital fly-by-wire flight control system, close-coupled wing-canard configuration, aeroelastically tailored composite wing skins, three-surface pitch control configuration, and a highly unstable airframe. The expansion of the aircraft 1-g and maneuver flight envelopes was recently completed over a two-year period in 84 flights. Overall flight results confirmed the viability of the aircraft design, and good agreement with preflight predictions was obtained. The individual technologies' operational workability and performance were confirmed. This paper deals with the flight test results and the preliminary evaluation of the X-29A design and technologies. A summary of the primary technical findings in structural static loads, structural dynamic characteristics, flight control system characteristics, aerodynamic stability and control, and aerodynamic performance is presented. Author

# 06 AIRCRAFT INSTRUMENTATION

Includes cockpit and cabin display devices; and flight instruments.

For related information see also *19 Spacecraft Instrumentation* and *35 Instrumentation and Photography.*

**N87-26907#** Essex Corp., Warminster, Pa.
**SYSTEMS TESTBED FOR AVIONIC RESEARCH (STAR) AUTOMATION CONCEPT DEVELOPMENT**
Paul G. Stringer and Daniel D. Riley Apr. 1987 336 p
(Contract N62269-83-D-0115)
(AD-A180658; AVSCOM-TR-86-E-2) Avail: NTIS HC A15/MF A01 CSCL 01C

The primary purpose of the work performed under this contract has been to develop an automation and avionics integration design concept permitting single-pilot operations. Recommendations for that design concept are provided in this report. These recommendations were derived through analyses of the U.S. Army Scout and Utility mission concepts, identification of suitable automation-candidate functions for the performance of those missions, assessment of automation technologies available, and, finally, the establishment of system design option preferences. Ultimately, these recommendations will impact the definition of design specification requirements for the NUH-60 Systems Testbed for Avionics Research (STAR) aircraft. GRA

# 07 AIRCRAFT PROPULSION AND POWER

Includes prime propulsion systems and systems components, e.g., gas turbine engines and compressors; and onboard auxilliary power plants for aircraft.

For related information see also *20 Spacecraft Propulsion and Power, 28 Propellants and Fuels,* and *44 Energy Production and Conversion.*

**N87-26908*#** Carnegie-Mellon Univ., Pittsburgh, Pa. Dept. of Mechanical Engineering.
**BLADED DISK VIBRATION Final Report**
J. H. Griffin Aug. 1987 5 p
(Grants NAG2-31; NAG3-67)
(NASA-CR-181203; NAS 1.26:181203) Avail: NTIS HC A02/MF A01 CSCL 21E

The objective was to better understand the vibratory response of bladed disk assemblies that occur in jet engines or turbopumps. Two basic problems were investigated: how friction affects flutter; and how friction, mistuning, and stage aerodynamics affect resonance. Understanding these phenomena allows a better understanding of why some stages have high vibratory stresses, how best to manage those stresses, and what to do about reducing them if they are too large. Author

**N87-26909#** Dayton Univ., Ohio. Research Inst.
**RESEARCH ON MECHANICAL PROPERTIES FOR ENGINE LIFE PREDICTION Annual Report no. 2, Aug. 1985 - 31 Jul. 1986**
Noel E. Ashbaugh, M. Khobaib, Tusit Weerasooriya, George A. Hartman, III, and David C. Maxwell May 1987 70 p
(Contract F33615-84-C-5051)
(AD-A181243; UDR-TR-86-141; AFWAL-TR-87-4011) Avail: NTIS HC A04/MF A01 CSCL 11F

Analytical and experimental investigations have been performed to determine crack growth behavior of turbine engine disk and blade alloys under various loading conditions typical of service environments. Tests were performed at elevated temperature in vacuum also to evaluate the baseline crack growth behavior. Substructural analysis of creep rupture specimens were conducted to understand the basic mechanism of time-dependent elevated temperature deformation. The work performed can be divided into three categories-- development of experimental techniques, material characterization techniques, and data maintenance and test support activities. The capability of the IDG laser system to monitor extended gage length was analyzed and found feasible. New grips and specimens have been designed and fabricated for high temperature composite testing. Enhancements to existing systems for crack length and displacement measurements were made. A number of computer automation applications are also discussed. GRA

**N87-26910*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**DESIGN AND PERFORMANCE OF CONTROLLED-DIFFUSION STATOR COMPARED WITH ORIGINAL DOUBLE-CIRCULAR-ARC STATOR**
Thomas F. Gelder, James F. Schmidt, Kenneth L. Suder, and Michael D. Hathaway (Army Aviation Systems Command,

Cleveland, Ohio.) [1987] 22 p Prepared for presentation at the Aerospace Technology Conference and Exposition, Long Beach, Calif., 5-8 Oct. 1987; sponsored by the Society of Automotive Engineers
(NASA-TM-100141; AVSCOM-TR-87-C-25; E-3694; NAS 1.15:100141) Avail: NTIS HC A02/MF A01 CSCL 21E

The capabilities of two stators, one with controlled-diffusion (CD) blade sections and one with double-circular-arc (DCA) blade sections, were compared. A CD stator was designed and tested that had the same chord length but half the blades of the DCA stator. The same fan rotor (tip speed, 429 m/sec; pressure ratio, 1.65) was used with each stator row. The design and analysis system is briefly described. The overall stage and rotor performances with each stator are compared, as are selected blade element data. The minimum overall efficiency decrement across the stator was approximately 1 percentage point greater with the CD balde sections than with the DCA blade sections. Author

**N87-26911#** Rolls-Royce Ltd., Derby (England).
**ADVANCED TURBINE BLADING: A CHALLENGE FOR DESIGNE R, MATERIALS DEVELOPER AND MANUFACTURER**
R. P. Arthey 5 Dec. 1986 7 p Presented at the Conference on Design with High Temperature Materials, York, England, 7-9 Apr. 1986
(PNR90365; ETN-87-90112) Copyright Avail: NTIS HC A02/MF A01

The concepts of wafer blading and spar shell construction for aircraft engine turbine blades are reviewed. The potential of hybrid blading is assessed. ESA

**N87-26912#** Rolls-Royce Ltd., Derby (England).
**ROLLS ROYCE CIVIL ENGINES, THE NEXT GENERATION**
G. Lewis 23 Jan. 1987 7 p Presented at the Air India Symposium, 23 Jan. 1986
(PNR90370; ETN-87-90113) Copyright Avail: NTIS HC A02/MF A01

Aircraft powerplant demand to the year 2000 is assessed, and the role of propfans, contrafans, and propellers is estimated. Operating costs are shown and aircraft configurations are shown. ESA

**N87-26913*#** National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
**THE VALUE OF EARLY FLIGHT EVALUATION OF PROPULSION CONCEPTS USING THE NASA F-15 RESEARCH AIRPLANE**
Frank W. Burcham, Jr. and Ronald J. Ray Sep. 1987 15 p Presented at the AIAA/AHS/ASEE Aircraft Design, Systems and Operations Meeting, St. Louis, Mo., 13-16 Sep. 1987
(NASA-TM-100408; H-1419; NAS 1.15:100408; AIAA-87-2877) Avail: NTIS HC A02/MF A01 CSCL 21E

The value of early flight evaluation of propulsion and propulsion control concepts was demonstrated on the NASA F-15 airplane in programs such as highly integrated digital electronic control (HIDEC), the F100 engine model derivative (EMD), and digital electronic engine control (DEEC). (In each case, the value of flight demonstration was conclusively demonstrated). This paper described these programs, and discusses the results that were not expected, based on ground test or analytical prediction. The role of flight demonstration in facilitating transfer of technology from the laboratory to operational airplanes is discussed. Author

**N87-26914*#** General Electric Co., Lynn, Mass. Aircraft Engines.
**CERAMIC HIGH PRESSURE GAS PATH SEAL Final Report, Jan. 1982 - Apr. 1987**
G. C. Liotta Aug. 1987 138 p
(Contract NAS3-23174)
(NASA-CR-180813; NAS 1.26:180813) Avail: NTIS HC A07/MF A01 CSCL 20E

Stage 1 ceramic shrouds (high pressure turbine gas path seal) were developed for the GE T700 turbine helicopter engine under the Army/NASA Contract NAS3-23174. This contract successfully proved the viability and benefits of a Stage 1 ceramic shroud for production application. Stage 1 ceramic shrouds were proven by extensive component and engine testing. This Stage 1 ceramic shroud, plasma sprayed ceramic (ZrOs-BY2O3) and bond coating (NiCrAlY) onto a cast metal backing, offers significant engine performance improvement. Due to the ceramic coating, the amount of cooling air required is reduced 20% resulting in a 0.5% increase in horsepower and a 0.3% decrease in specific fuel consumption. This is accomplished with a component which is lower in cost than the current production shroud. Stage 1 ceramic shrouds will be introduced into field service in late 1987. Author

# 08 AIRCRAFT STABILITY AND CONTROL

Includes aircraft handling qualities; piloting; flight controls; and autopilots.

For related information see also *05 Aircraft Design, Testing and Performance.*

**N87-26915*#** Purdue Univ., West Lafayette, Ind. School of Aeronautics and Astronautics.
**MULTI-INPUT MULTI-OUTPUT SYSTEM CONTROL FOR EXPERIMENTAL AIRCRAFT Final Technical Report**
David K. Schmidt 20 Aug. 1987 58 p
(Contract NCC2-288)
(NASA-CR-181197; NAS 1.26:181197) Avail: NTIS HC A04/MF A01 CSCL 01C

Results from the synthesis of control laws for an advanced short takeoff aircraft in a low-speed approach flight condition are given. Two of four candidate synthesis techniques are reported: direct eigenspace assignment and explicit model following via a linear quadratic regulator (LQR) formulation. A fundamental objective of this work is to obtain low-order feedback compensators, synthesized via the above techniques, and the judicious use of state estimation, thus allowing the use of a reasonable number of sensors for feedback. Author

**N87-26916#** Aeronautical Research Labs., Melbourne (Australia).
**THE COMPUTED GUST RESPONSE OF AN AIRCRAFT. THE RELATIVE EFFECT OF VARIOUS DEGREES OF FREEDOM**
S. C. Galea Jul. 1986 135 p
(AD-A180968; ARL-STRUC-TM-447) Avail: NTIS HC A07/MF A01 CSCL 01A

A typical jet transport aircraft has been modelled with increasing numbers of degrees of freedom. Transfer functions and spectral parameters, A and N sub o, were evaluated using two gust models. The first gust model consisted of gust variations in the streamwise direction alone. The second model, a two dimensional gust model, is made up of variations in both the streamwise and spanwise direction. In both of these cases a von Karman gust spectrum, with integral scale of turbulence of 688m, was assumed. As the degree of flexibility of the model was augmented from one to five degrees of freedom the spectral parameter, A, increased by 8%. The value of N sub o was strongly biased by the high frequency response of the model. Therefore it was concluded that trends in N sub o with system flexibility, could not be determined accurately until the asymptotic behavior of the response is known. For the five degree of freedom model the introduction of spanwise variations in gust caused only slight variations in the spectral parameters A and N sub o. GRA

**N87-26917#** Calspan Advanced Technology Center, Buffalo, N.Y.
**EXPERIMENTAL INVESTIGATION OF THE SHORT-PERIOD REQUIREMENTS OF MIL-F-8785C, VOLUME 2 Interim Report, Jun. 1984 - Dec. 1985**
Randall E. Bailey Nov. 1986 211 p
(Contract F33615-83-C-3603)
(AD-A181475; CALSPAN-7205-9-Vol-2; AFWAL-TR-86-3109-Vol-2) Avail: NTIS HC A10/MF A01 CSCL 01D

An investigation of the short period frequency requirements of MIL-F-8785C was performed using an in-flight simulator. Thirty-five evaluations of eighteen configurations were conducted. The experiment examined the minimum frequency boundary at three values of alpha for one true airspeed. The experiment included the effects of pilot location and evaluation task. The data indicate that the current requirement is essentially valid. The minimum acceptable frequency boundary may be relaxed, however, when the pilot station is forward of the center of rotation. Also, the phasing between the normal acceleration and pitch rate responses has been shown to be a critical determinant of longitudinal short period flying qualities. The results are analyzed also using the equivalent systems methodology. GRA

**N87-26918*#** Boeing Commercial Airplane Co., Seattle, Wash.
**NASA B737 FLIGHT TEST RESULTS OF THE TOTAL ENERGY CONTROL SYSTEM**
Kevin R. Bruce Jul. 1987 103 p
(Contract NAS1-17509)
(NASA-CR-178285; NAS 1.26:178285) Avail: NTIS HC A06/MF A01 CSCL 01C

The Total Energy Control System (TECS) is an integrated autopilot/autothrottle developed by BCAC that was test flown on NASA Langley's Transport System Research Vehicle (i.e., a highly modified Boeing B737). This systems was developed using principles of total energy in which the total kinetic and potential energy of the airplane was controlled by the throttles, and the energy distribution controled by the elevator. TECS integrates all the control functions of a conventional pitch autopilot and autothrottle into a single generalized control concept. This integration provides decoupled flightpath and maneuver control, as well as a coordinated throttle response for all maneuvers. A mode hierarchy was established to preclude exceeding airplane safety and performance limits. The flight test of TECS took place as a series of five flights over a 33-week period during September 1985 at NASA Langley. Most of the original flight test plan was completed within the first three flights with the system not exhibiting any instabilities or design problems that required any gain adjustment during flight. Author

**N87-26919*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**PILOTED SIMULATOR STUDY OF ALLOWABLE TIME DELAY IN PITCH FLIGHT CONTROL SYSTEM OF A TRANSPORT AIRPLANE WITH NEGATIVE STATIC STABILITY**
William D. Grantham, Paul M. Smith, Lee H. Person, Jr., Robert T. Meyer, and Stephen A. Tingas (Lockheed-Georgia Co., Marietta.) Sep. 1987 32 p
(NASA-TM-89147; L-16282; NAS 1.15:89147) Avail: NTIS HC A03/MF A01 CSCL 01C

A piloted simulation study was conducted to determine the permissible time delay in the flight control system of a 10-percent statically unstable transport airplane during cruise flight conditions. The math model used for the simulation was a derivative Lockheed L-1011 wide-body jet transport. Data were collected and analyzed from a total of 137 cruising flights in both calm- and turbulent-air conditions. Results of this piloted simulation study verify previous findings that show present military specifications for allowable control-system time delay may be too stringent when applied to transport-size airplanes. Also, the degree of handling-qualities degradation due to time delay is shown to be strongly dependent on the source of the time delay in an advanced flight control system. Maximum allowable time delay for each source of time delay in the control system, in addition to a less stringent overall maximum level of time delay, should be considered for large aircraft. Preliminary results also suggest that adverse effects of control-system time delay may be at least partially offset by variations in control gearing. It is recommended that the data base include different airplane baselines, control systems, and piloting tasks with many pilots participating, so that a reasonable set of limits for control-system time delay can be established to replace the military specification limits currently being used. Author

**N87-26920*#** National Aeronautics and Space Administration. Hugh L. Dryden Flight Research Center, Edwards, Calif.
**DYNAMIC STABILITY AND HANDLING QUALITIES TESTS ON A HIGHLY AUGMENTED, STATICALLY UNSTABLE AIRPLANE**
Joseph Gera and John T. Bosworth Aug. 1987 16 p Presented at the AIAA Guidance, Navigation and Control Conference, Monterey, Calif., 17-19 Aug. 1987and at SFTE 18th Annual Symposium, Amsterdam, Netherlands, 28 Sep. - 2 Oct. 1987
(NASA-TM-88297; H-1422; NAS 1.15:88297; AIAA-87-2258-CP)
Avail: NTIS HC A02/MF A01 CSCL 01C

Initial envelope clearance and subsequent flight testing of a new, fully augmented airplane with an extremely high degree of static instability can place unusual demands on the flight test approach. Previous flight test experience with these kinds of airplanes is very limited or nonexistent. The safe and efficient flight testing may be further complicated by a multiplicity of control effectors that may be present on this class of airplanes. This paper describes some novel flight test and analysis techniques in the flight dynamics and handling qualities area. These techniques were utilized during the initial flight envelope clearance of the X-29A aircraft and were largely responsible for the completion of the flight controls clearance program without any incidents or significant delays. Author

**N87-26921** Virginia Polytechnic Inst. and State Univ., Blacksburg.
**AN INVESTIGATION OF METHODOLOGY FOR THE CONTROL AND FAILURE IDENTIFICATION OF FLEXIBLE STRUCTURES Ph.D. Thesis**
Zeen Chul Kim 1986 129 p
Avail: Univ. Microfilms Order No. DA8704683

The characteristics of four methods is examined for the control of flexible structures and the control performances of each method. Various control performance measures, such as control gain magnitude, settling time and overshoot in transient response, actuator phase and gain margins, and stability in the presence of actuator failure are emphasized. In conjunction with the system performance, a systematic approach to the choice of weighting matrices for optimal control is presented. The approach shows a relation between the weighting matrices and the closed loop eigenvalues. The robustness of Independent Modal Space Control (IMSC) is examined. In general, the parameters of the control system are usually approximated, so that the designed controller, based on a postulated model, will not perform on the actual system as expected. It is shown that when the IMSC method is used with collocated sensors and actuators, the modelling errors in the postulated system cannot lead to instability of the closed loop system containing control modes and residual modes. However, in the case of coupled control (MGPP), this property cannot be shown. This points to the robustness of the IMSC method with respect to the modelling errors. Author

**N87-26922*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**PILOTED-SIMULATION STUDY OF EFFECTS OF VORTEX FLAPS ON LOW-SPEED HANDLING QUALITIES OF A DELTA-WING AIRPLANE**
Jay M. Brandon, Philip W. Brown, and Alfred J. Wunschel Sep. 1987 38 p
(NASA-TP-2747; L-16307; NAS 1.60:2747) Avail: NTIS HC A03/MF A01 CSCL 01C

A piloted-simulation study was conducted to investigate the effects of vortex flaps on low-speed handling qualities of a delta-wing airplane. The simulation math model was developed from wind tunnel tests of a 0.15 scale model of the F-106B airplane. Pilot evaluations were conducted using a six-degree-of-freedom motion base simulator. The results of the investigation showed that the reduced static longitudinal stability caused by the vortex flaps significantly degraded handling qualities in the approach-to-landing task. Acceptable handling qualities could be achieved by limiting the aft center-of-gravity location, consequently reducing the operational envelope of the airplane. Further

improvement were possible by modifying the flight control force-feel system to reduce pitch-control sensitivity. Author

# 09 RESEARCH AND SUPPORT FACILITIES (AIR)

Includes airports, hangars and runways; aircraft repair and overhaul facilities; wind tunnels; shock tubes; and aircraft engine test stands.

For related information see also *14 Ground Support Systems and Facilities (Space).*

**N87-26923*#** Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.

**IMPLEMENTATION AND VALIDATION OF A WAKE MODEL FOR VORTEX-SURFACE INTERACTIONS IN LOW SPEED FORWARD FLIGHT Semiannual Status Report, 1 Oct. 1986 - 31 Mar. 1987**

Narayanan M. Komerath and Olivier A. Schreiber Mar. 1987 27 p

(Grant NAG1-693)

(NASA-CR-180623; NAS 1.26:180623) Avail: NTIS HC A03/MF A01 CSCL 14B

The wake model was implemented using a VAX 750 and a Microvax II workstation. Online graphics capability using a DISSPLA graphics package. The rotor model used by Beddoes was significantly extended to include azimuthal variations due to forward flight and a simplified scheme for locating critical points where vortex elements are placed. A test case was obtained for validation of the predictions of induced velocity. Comparison of the results indicates that the code requires some more features before satisfactory predictions can be made over the whole rotor disk. Specifically, shed vorticity due to the azimuthal variation of blade loading must be incorporated into the model. Interactions between vortices shed from the four blades of the model rotor must be included. The Scully code for calculating the velocity field is being modified in parallel with these efforts to enable comparison with experimental data. To date, some comparisons with flow visualization data obtained at Georgia Tech were performed and show good agreement for the isolated rotor case. Comparison of time-resolved velocity data obtained at Georgia Tech also shows good agreement. Modifications are being implemented to enable generation of time-averaged results for comparison with NASA data. B.G.

**N87-26924*#** Old Dominion Univ., Norfolk, Va. Dept. of Mechanical Engineering and Mechanics.

**WIND TUNNEL MAGNETIC SUSPENSION AND BALANCE SYSTEMS Progress Report, 16 Nov. 1986 - 30 Sep. 1987**

Colin P. Britcher Apr. 1987 22 p

(Grant NAG1-716)

(NASA-CR-180555; NAS 1.26:180555) Avail: NTIS HC A02/MF A01 CSCL 14B

Calibration of the 13 inch Magnetic Suspension and Balance System (MSBS) is nearing completion. Preparatory aerodynamic tests of bodies of revolution is ongoing, with preliminary data already presented. Analysis of the design of the proposed demonstration levitation systems is also ongoing. The analysis requires the availability of the sophisticated computer code GFUN. The procurement of this code was delayed by numerous factors and is still not delivered to LaRC. Installation and use of this code is expected to represent a major portion of activity in the remaining period of the grant. B.G.

**N87-26925#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.

**EXPERIMENTAL RESEARCH FROM LOW SPEED TWO DIMENSIONAL FLEXIBLE WALL SELF STREAMLINING WIND TUNNELS**

Jiaju He, Peichu Zuo, and Huaxing Li 11 May 1987 21 p Transl. into ENGLISH from Hangkong Xuebao (China), v. 7, no. 3, 1986 p 217-224

(AD-A180993; FTD-ID(RS)T-0135-87) Avail: NTIS HC A02/MF A01 CSCL 20D

This article discusses the selection of the design parameters and the special structural points of the Northwestern Polytechnical Univ low speed, two-dimensional flexible wall self-streamlining wind tunnel. It also introduces the wind tunnel flow field operation, the self-streamlining iterative substitution design, the experimental operation programming, and the initial experimental results. As far as concerns the cylinder model with blockage ratio epsilon = 13.7% and the NACA0012 airfoil zero lift configuration with height to chord ratio of H/c = 1.28, after going through the process of 2-4 iterative substitutions in the self-streamlining model, it is even easier to get convergence and obtain a non-interference value which corresponds with the relevent reference materials and the world's self-correcting wind tunnels. GRA

**N87-26926#** Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.

**COMPUTER CONTROLLED CALIBRATION OF HIGH PRECISION PRESSURE TRANSDUCERS**

E. W. deKeizer Oct. 1985 19 p

(VTH-LR-468; B8707443; ETN-87-90209) Avail: NTIS HC A02/MF A01

An automatic pressure transducer calibration system was developed. Using an HP-1000 computer system and a quartz bourdon tube manometer, a 20-point calibration of 1 or more pressure tranducers mounted in or near a wind tunnel is performed in 20 min, with overall accuracy of 0.02% full scale. Several pressure transducers with similar pressure ranges may be calibrated simultaneously. Polynomial calibration coefficients and a graph representing the residual errors of the calibrated pressures when using these coefficients for each of the calibrated transducers is provided. The operating system allows the calibration process to proceed concurrently with other tasks like editing and compiling of programs under development. Pressure measuring devices not connected to the data acquisition system can also be calibrated. ESA

# 12 ASTRONAUTICS (GENERAL)

For extraterrestrial exploration see *91 Lunar and Planetary Exploration.*

No abstracts in this category.

# 13 ASTRODYNAMICS

Includes powered and free-flight trajectories; and orbital and launching dynamics.

**N87-26927*#** Georgia Inst. of Tech., Atlanta. School of Aerospace Engineering.

**SINGULAR PERTURBATION ANALYSIS OF AOTV RELATED TRAJECTORY OPTIMIZATION PROBLEMS Progress Report, 14 Apr. - 30 Oct. 1986**

Anthony J. Calise Nov. 1986 16 p

(Grant NAG1-660)

(NASA-CR-180301; NAS 1.26:180301) Avail: NTIS HC A02/MF A01 CSCL 22A

The problem of aeroassisted orbital plane change is discussed. This maneuver requires the use of three impulses - one to deorbit, one to reorbit and one to recircularize at the new orbit. The orbit plane change is effected entirely in the atmosphere through the use of lift and bank angle control. For circular orbits of nearly equal radii, it can be shown that the fuel consumption is minimized by minimizing the energy loss in the atmospheric portion of the trajectory. The research explores the use of singular perturbation theory to develop an optimal guidance law for the atmospheric portion. Author

**N87-26928#** Logica Ltd., London (England).
**GEOSTATIONARY ORBIT CAPACITY STUDY, PHASE 2. RELATIVE COMPARISON OF FUTURE MULTIMISSION PAYLOADS, SUMMARY**
P. Hansell, R. Krawec, and M. Elliott (British Aircraft Corp., Luton, England ) Paris, France ESA 27 Feb. 1986 61 p
(Contract ESA-5278/82-F-RD(SC))
(Rept-74.4197; ESA-CR(P)-2321; ETN-87-99978) Copyright
Avail: NTIS HC A04/MF A01

A telecommunication traffic model for Western Europe up to the year 2005 especially for TV requirements was developed. An interference model to accommodate complex satellite coverage areas was derived. Methods to obtain satellite antenna coverage contours direct from published regulatory documents were assessed. Based on the traffic forecasts and spacecraft mass/power modeling, multimission systems using the 14/12/11 and 30/20 GHz allocations, solely or in combination, were selected. Interference and cost modeling of the missions was done. France, Germany, Italy, Scandinavia, Spain, and UK are expected to provide domestic spacecraft. Television requirements are expected to be the main system driver. In view of this and because of the interference problems caused by FMTV, a drive toward digital TV at as low bit rates as possible is necessary. A regional system also providing domestic payloads appears to be a cost effective solution. ESA

# 14 GROUND SUPPORT SYSTEMS AND FACILITIES (SPACE)

Includes launch complexes, research and production facilities; ground support equipment, e.g., mobile transporters; and simulators.

For related information see also *09 Research and Support Facilities (Air).*

**N87-26929#** Aerodyne Products Corp., Billerica, Mass.
**HYPERVELOCITY OXYGEN SOURCE FOR THE STUDY OF ATOM-SURFACE INTERACTIONS Final Report**
Andrew Freedman and William Unkel Apr. 1987 62 p
(Contract F49620-86-C-0091)
(AD-A181618; ARI-RR-588; AFOSR-87-0661TR) Avail: NTIS HC A04/MF A01 CSCL 07D

Space-based facilities face an unexpectedly hostile environment at orbital altitudes due to chemical interaction with atomic oxygen at high velocities (typically 8 km/s). Shuttle-based experiments indicate substantial degradation and erosion of various materials which face into the atmospheric wind. This document reports the efforts of a project intended to design a high velocity, high flux atomic oxygen beam source capable of simulating the space environment. Also included are plans for a vacuum apparatus which will provide for the diagnostic techniques needed to evaluate the source peformances as well as allow for materials testing. The oxygen atom beam source is based on the concept of admixing a small quantity of molecular oxygen into a gas stream of helium that had been electric discharge heated using a commercially available plasma touch. Extensive modeling has suggested improvements in a previous version of the source that should allow production of 8 km/s beams with atomic oxygen fluxes of 1 x 10 to the 17th power/cm sq/s at 10 cm distance from the source aperture. GRA

# 15 LAUNCH VEHICLES AND SPACE VEHICLES

Includes boosters; operating problems of launch/space vehicle systems; and reusable vehicles.

For related information see also *20 Spacecraft Propulsion and Power.*

No abstracts in this category.

# 16 SPACE TRANSPORTATION

Includes passenger and cargo space transportation, e.g., shuttle operations; and space rescue techniques.

For related information see also *03 Air Transportation and Safety* and *18 Spacecraft Design, Testing and Performance.* For space suits see *54 Man/System Technology and Life Support.*

**N87-26930*#** National Aeronautics and Space Administration. John F. Kennedy Space Center, Cocoa Beach, Fla.
**CHRONOLOGY OF KSC AND KSC-RELATED EVENTS FOR 1985**
Ken Nail, Jr. and Elaine Liston (New World Services, Inc., Fla.) Mar. 1986 121 p
(NASA-TM-89364; KSC-KHR-10; NAS 1.15:89364) Avail: NTIS HC A06/MF A01 CSCL 22A

A chronology of developments and events at the Kennedy Space Center (KSC) in 1985 documents the KSC role in NASA's progress. The chronology serves as a reference source for historians and other researchers. Arrangement is by day and month. Individual articles are attributed to published sources. Author

**N87-26931#** Systems Science and Software, La Jolla, Calif. Jolla Ca.
**POLAR CODE CALCULATIONS OF THE SHUTTLE ORBITER PLASMA WAKE AND DIRECT COMPARISONS WITH SPACELAB 2 MEASUREMENTS**
I. Katz, G. A. Jongeward, J. R. Lilley, Jr., and M. J. Mandell Nov. 1986 143 p
(Contract F19628-86-C-0056)
(AD-A181160; SSS-R-87-8506; AFGL-TR-87-0041; SR-4) Avail: NTIS HC A07/MF A01 CSCL 22A

Prior to the 1985 launch of Spacelab 2, arrangements were made to use the POLAR code to predict the wake of the shuttle orbiter which was to be measured by the Plasma Diagnostics Package (PDP) satellite. This report describes the comparison of POLAR code calculations with the plasma density measurements made on the PDP. All calculations were made prior to the availability of any information on the measured results; there were no adjustable parameters. The overall qualitative features of the calculated wake agreed well with the experiment. For the four major wake transits, the measured depletions differed from the POLAR computer predictions by 15% or less. GRA

**N87-26962#** Air Force Geophysics Lab., Hanscom AFB, Mass.
**POLAR-AURORAL CHARGING OF THE SPACE SHUTTLE AND EVA ASTRONAUT**
William N. Hall, Philip Leung, Ira Katz, Gary A. Jongeward, John R. Lilley, Jr., Joseph E. Nanevicz, Jeffrey S. Thayer, and N. John Stevens (TRW, Inc., Redondo Beach, Calif.) *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 9 p
(For primary document see N87-26937 21-18)
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# 17 SPACE COMM., SPACECRAFT COMM., COMMAND & TRACKING

Includes telemetry; space communications networks; astronavigation and guidance; and radio blackout.

For related information see also *04 Aircraft Communications and Navigation* and *32 Communications and Radar.*

**N87-26932#** Defense Mapping Agency Hydrographic and Topographic Center, Washington, D.C.
**DMA (DEFENSE MAPPING AGENCY) ORBIT DETERMINATION OF THE NAVY NAVIGATION SATELLITE SYSTEM 1986 Final Annual Report no. 2, Jan. - Dec. 1986**
J. K. Murphy and Robert J. Jones 1 Apr. 1987 42 p
(AD-A181107) Avail: NTIS HC A03/MF A01 CSCL 08E

The Defense Mapping Agency Hydrographic/Topographic Center (DMAHTC) performs precise orbit computations for Navy Navigation Satellite (NNSS) satellites (also called TRANSIT), using Doppler observations collected by a worldwide network of stations. Equipment at these sites is configured around either a Tranet II or a Magnavox 1502 DS receiver. The current stations are listed and tracking network configuration shown. Recorded Doppler counts, surface weather measurements, and other appropriate data are transmitted daily via satellite communications or over telecommunication links to DMATHC for processing, time corrections and orbit determination. There are two classes of NNSS satellites -- the Oscar and the Nova. The Nova satellites represent the latest generation of TRANSIT satellites. For Nova satellite 30480 and Oscar satellites 30110, 30130, 30200 and 30300, data were processed in two-day fits. For Nova satellite 30500, data were processed in two-day fits. GRA

**N87-26933#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**A STUDY ON MODULATION/DEMODULATION FOR A SATELLITE ANALOG TELEMETRY SYSTEM**
Chen Yiyuan 18 May 1987 31 p Transl. into ENGLISH from Yuhang Xuebao (China), v. 86, no. 2, 1986 p 61-71
(AD-A181251; FTD-ID(RS)T-0196-87) Avail: NTIS HC A03/MF A01 CSCL 09F

The analog telemetry subcarrier channel for satellites employs the FSK modulation scheme. The primary information transmitted is the time of the pulse front. However, the time at which a pulse appears varies. Therefore, it is similar to the PPM-FM modulation scheme. In the demodulation process, the bandwidth is increased to improve the time resolution. However, increasing bandwidth will lower the signal-to-noise ratio of the channel and the probability of making an error is greatly increased. Hence, a suitable bandwidth must be selected. This paper discusses the principle and advantages of the cross level detection method. It is better than the fixed level detection method in time resolution and decision failure probability. GRA

**N87-26934*#** Draper (Charles Stark) Lab., Inc., Cambridge, Mass.
**AN ADAPTIVE NUMERIC PREDICTOR-CORRECTOR GUIDANCE ALGORITHM FOR ATMOSPHERIC ENTRY VEHICLES M.S. Thesis - MIT, Cambridge**
Kenneth Milton Spratlin May 1987 206 p
(Contract NAS9-17560)
(NASA-CR-171989; NAS 1.26:171989; CSDL-T-950) Avail: NTIS HC A10/MF A01 CSCL 22A

An adaptive numeric predictor-corrector guidance is developed for atmospheric entry vehicles which utilize lift to achieve maximum footprint capability. Applicability of the guidance design to vehicles with a wide range of performance capabilities is desired so as to reduce the need for algorithm redesign with each new vehicle. Adaptability is desired to minimize mission-specific analysis and planning. The guidance algorithm motivation and design are presented. Performance is assessed for application of the algorithm to the NASA Entry Research Vehicle (ERV). The dispersions the guidance must be designed to handle are presented. The achievable operational footprint for expected worst-case dispersions is presented. The algorithm performs excellently for the expected dispersions and captures most of the achievable footprint. Author

**N87-26935*#** Draper (Charles Stark) Lab., Inc., Cambridge, Mass.
**COLLISION DETECTION FOR SPACECRAFT PROXIMITY OPERATIONS Ph.D. Thesis - MIT**
Robin M. Vaughan May 1987 357 p
(Contract NAS9-17560)
(NASA-CR-171988; NAS 1.26:171988; CSDL-T-953) Avail: NTIS HC A16/MF A01 CSCL 22A

The development of a new collision detection algorithm to be used when two spacecraft are operating in the same vicinity is described. The two spacecraft are modeled as unions of convex polyhedra, where the polyhedron resulting from the union may be either convex or nonconvex. The relative motion of the two spacecraft is assumed to be such that one vehicle is moving with constant linear and angular velocity with respect to the other. The algorithm determines if a collision is possible and, if so, predicts the time when the collision will take place. The theoretical basis for the new collision detection algorithm is the C-function formulation of the configuration space approach recently introduced by researchers in robotics. Three different types of C-functions are defined that model the contacts between the vertices, edges, and faces of the polyhedra representing the two spacecraft. The C-functions are shown to be transcendental functions of time for the assumed trajectory of the moving spacecraft. The capabilities of the new algorithm are demonstrated for several example cases. Author

# 18 SPACECRAFT DESIGN, TESTING AND PERFORMANCE

Includes satellites; space platforms; space stations; spacecraft systems and components such as thermal and environmental controls; and attitude controls.

For life support systems see *54 Man/System Technology and Life Support.* For related information see also *05 Aircraft Design, Testing and Performance, 39 Structural Mechanics,* and *16 Space Transportation.*

**N87-26936*#** Georgia Inst. of Tech., Atlanta. School of Mechanical Engineering.
**DEVELOPMENT OF AN EMULATION-SIMULATION THERMAL CONTROL MODEL FOR SPACE STATION APPLICATION Semiannual Status Report**
James G. Hartley and Gene T. Colwell Oct. 1986 63 p
(Grant NAG1-551)
(NASA-CR-180312; NAS 1.26:180312) Avail: NTIS HC A04/MF A01 CSCL 22B

The orbiting space station being developed by NASA will have many thermal sources and sinks as well as requirements for the transport of thermal energy through large distances. The station is also expected to evolve over twenty or more years from an initial design. As the station evolves, thermal management will become more difficult. Thus, analysis techniques to evaluate the effects of changing various thermal loads and the methods utilized to control temperature distributions in the station are essential. Analysis techniques, including a user-friendly computer program, were developed which should prove useful to thermal designers and system analysts working on the space station. The program uses a data base and user input to compute costs, sizes, and power requirements for individual components and complete systems. User input consists of selecting mission parameters, selecting thermal acquisition configurations, transport systems and distances, and thermal rejection configurations. The capabilities of the program may be expanded by including additional thermal models as subroutines. Author

**N87-26937#** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Electromagnetic Wave Propagation Panel.

**THE AEROSPACE ENVIRONMENT AT HIGH ALTITUDES AND ITS IMPLICATIONS FOR SPACECRAFT CHARGING AND COMMUNICATIONS**

May 1987 286 p In ENGLISH and FRENCH Symposium held in The Hague, Netherlands, 2-6 Jun. 1986

(AGARD-CP-406; ISBN-92-835-0418-6) Copyright Avail: NTIS HC A13/MF A01 CSCL 22B

The symposium examined how the magnetosphere and polar plasmas vary as a result of natural causes and man-made perturbations, and the implications of these variations for the charging and differential charging of spacecraft with their effects, in turn, on spacecraft systems and communications. A better understanding of these phenomena can help to design of spacecraft systems and subsystems to minimize the effects of these disturbances. For individual titles, see N87-26938 through N87-26962.

**N87-26938#** Institut d'Aeronomie Spatiale de Belgique, Brussels.

**THE QUIET AND DISTURBED PLASMASPHERE** **c46**

J. Lemaire *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 7 p Previously announced as N87-22498 (For primary document see N87-26937 21-18)

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The plasmasphere and plasmapause are described from an observational point of view. The main properties of this inner magnetospheric region are recalled. The dynamical response of the plasmasphere to enhancements of geomagnetic activity is considered. The peeling off of the nightside plasmasphere at the onset of enhanced magnetospheric convection events is discussed. The dayside refilling mechanism is addressed. Author

**N87-26939#** Utah State Univ., Logan. Center for Atmospheric and Space Sciences.

**MAGNETOSPHERIC CONTROL OF THE BULK IONOSPHERIC PLASMA** **c46**

J. J. Sojka and R. W. Schunk *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 14 p (For primary document see N87-26937 21-18)

(Grant NSF ATM-84-17880)

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The temperature, composition, and circulation of high latitude ionosphere display a marked variation with altitude, longitude, universal time, season, solar cycle and geomagnetic activity. To a large degree this variation is a consequence of the effect that magnetospheric electric fields, particle precipitation, and heat flows have on the ionosphere. These and other aspects of the ionosphere's response to changing magnetospheric conditions are discussed using a time dependent ionospheric model. Author

**N87-26940#** Institut d'Aeronomie Spatiale de Belgique, Brussels.

**A MODEL FOR AN ELECTROMOTIVE FORCE GENERATOR IN THE MAGNETOSPHERE: A SOURCE OF DISCRETE AURORAL ARCS** **c46**

M. Roth, D. S. Evans (National Oceanic and Atmospheric Administration, Boulder, Colo.), and J. Lemaire *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 12 p Previously announced as N87-17421 (For primary document see N87-26937 21-18)

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Results obtained from solving Maxwell's and Vlasov's equations to obtain the electrical structure of the sheath that separates magnetospheric particle populations of different densities and temperatures are presented. It is shown that for reasonable magnetospheric plasma populations, an electric potential difference of several kilovolts exists across such a boundary. The potential can serve as the necessary electromotive force for the auroral current circuit. The colocation between a magnetospheric boundary and a discrete aurora is a natural consequence of this picture. Author

**N87-26941#** Los Alamos National Lab., N. Mex.

**HOSTILE ENERGETIC PARTICLE RADIATION ENVIRONMENTS IN EARTH'S OUTER MAGNETOSPHERE** **c46**

D. N. Baker, R. D. Belian, P. R. Higbie, R. W. Klebesadel, and J. B. Blake (Aerospace Corp., El Segundo, Calif.) *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 16 p Previously announced as N86-32018 (For primary document see N87-26937 21-18)

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Particular emphasis is given to highly relativistic electrons (3 approx. 10 MeV). Electron fluxes and energy spectra are shown that were measured by two high energy electron sensor systems at 6.6 R sub E from 1979 through 1984. Large, persistent increases in this population were found to be relatively infrequent and sporadic in 1979 to 1981 around solar maximum. During the approach to solar minimum (1981 to present) it is observed that the highly relativistic electrons occur with a regular 27-day periodicity and are well associated with the reestablished solar wind stream structures. The present analysis suggests that the Jovian magnetosphere is a recurrent source of this significant electron population in the outer terrestrial magnetosphere and that these electrons have a very deleterious effect on spacecraft systems due to deep dielectric charging and low-dose susceptibility effects. Author

**N87-26942#** Royal Aircraft Establishment, Farnborough (England). Radio and Navigation Dept.

**THE USE OF Pi2 PULSATIONS AS INDICATORS OF SUBSTORM EFFECTS AT GEOSTATIONARY ORBIT** **c46**

M. Lester *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 9 p (For primary document see N87-26937 21-18)

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Some of the characteristics of Pi2 pulsations observed at mid-latitudes on the ground are reviewed and the use of certain characteristics in indicating various magnetic and particle perturbations occurring during substorms are assessed. Spacecraft charging and its effects at geosynchronous orbit also reviewed. There is a brief discussion of how Pi2 pulsations might be used to predict intervals of spacecraft charging at geosynchronous orbit. Author

**N87-26943#** Stanford Univ., Calif. STAR Lab.

**WAVE-INDUCED PARTICLE PRECIPITATION FROM THE MAGNETOSPHERE AND THE ASSOCIATED IONOSPHERIC PERTURBATIONS** **c46**

U. S. Inan *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 10 p (For primary document see N87-26937 21-18)

(Grants NSF DPP-82-17820; NSF DPP-80-22282)

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A brief review of the gyroresonant wave-induced precipitation of energetic radiation belt particles is presented using the particular case of interactions involving lightning-generated whistler waves as an example. The interaction physics is first discussed in the context of results from a recently developed theoretical model of the whistler-particle scattering process occurring in the magnetosphere. This is followed by a discussion of the Trimpi effect, a particularly sensitive ground-based technique that has recently been used for detecting ionospheric perturbations produced by whistler-induced energetic particle precipitation from the magnetosphere on L-shells of 2 to 5. Author

**N87-26944*#** California Univ., San Diego, La Jolla. Center for Astrophysics and Space Sciences.
**HIGH SPACECRAFT POTENTIALS ON ISEE-1 IN SUNLIGHT**
E. C. Whipple, Jr. and R. C. Olsen (Alabama Univ., Huntsville.) *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 10 p (For primary document see N87-26937 21-18)
(Grant NAG-320)
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Data from two electric field experiments and from the plasma composition experiment on ISEE-1 show that the spacecraft charged to close to -70 V in sunlight at about 0700 UT on March 17, 1978. Data from the electron spectrometer experiment show that there was a potential barrier of some -10 to -20 V about the spacecraft during this event. The potential barrier was effective in turning back emitted photoelectrons to the spacecraft. Potential barriers can be formed by differential charging on the spacecraft or by the presence of space charge. The stringent electrostatic cleanliness specifications imposed on ISEE made the presence of differential charging seem unlikely, if these precautions were effective. Modeling of the event to determine if the barrier was produced by the presence of space charge suggested that this could not explain the observed barrier. The angular shape of the distribution could be successfully modeled as a product of differential charging on the solar arrays. This implies that the conductive coating was not completely effective in preventing differential charging, and that differential charging did occur.
Author

**N87-26945*#** Utah State Univ., Logan.
**ACTIVE VEHICLE CHARGING MEASUREMENTS IN SOUNDING ROCKET AND SPACE SHUTTLE ORBITER ENVIRONMENTS AT LOW EARTH ORBIT (LEO) ALTITUDE**
W. J. Raitt, J. V. Eccles, N. B. Myers, D. C. Thompson, P. M. Banks, P. R. Williamson, R. I. Bush, J. Hawkins, S. Sasaki, K.-I. Oyama (Tokyo Univ., Japan ) et al. *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 16 p (For primary document see N87-26937 21-18)
(Contracts NAS8-36011; F19628-86-K-0015)
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It was concluded that for electron beam emission up to 100mA, vehicle charging is not a significant problem with the Space Shuttle Orbiter. Similarly, sounding rocket payloads have no serious charging problems up to this level of beam current, provided that the maximum amount of the rocket skin is available to collect ionospheric electrons from the LEO altitude range. However, sounding rockets are marginal in their collecting area capability and other effects may occur to balance the beam current when operated at lower altitudes during the night.
Author

**N87-26946*#** Alabama Univ., Huntsville. Dept. of Physics.
**ELECTRON BEAM EXPERIMENTS AT HIGH ALTITUDES**
R. C. Olsen *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 8 p (For primary document see N87-26937 21-18)
(Grant NAG3-620)
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Experiments with the electron gun on the SCATHA satellite produced evidence of beam-plasma interactions, and heating of the low energy electrons around the satellite. These experiments were conducted near geosynchronous orbit, in the dusk bulge, and plasma sheet, with one short operation in the lobe regions, providing a range of ambient plasma densities. The electron gun was operated at 50 eV, with beam currents of 1, 10, and 100 micro-A. Data from electrostatic analyzers and the DC electric field experiment show that the satellite charged to near the beam energy in sunlight, if the beam current was sufficient. Higher ambient densities required higher beam currents. The electrostatic analyzers showed distribution functions which had peaks, or plateaus, at energies greater than the satellite potential. These measurements indicate heating of the ambient plasma at several Debye lengths from the satellite, with the heated plasma then accelerated into the satellite. It is likely that the ambient plasma is in fact the photoelectron sheath generated by the satellite.
Author

**N87-26947*#** Physikalisch-Technische Studien G.m.b.H., Freiburg (West Germany).
**GIOTTO-SPACECRAFT CHARGING DUE TO IMPACT GENERATED PLASMA IN THE PRESENCE OF DIELECTRIC MATERIALS**
H. Thiemann, R. W. Schunk, N. Singh, and R. Grard (European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk, Netherlands ) *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 7 p (For primary document see N87-26937 21-18)
(Grants NAGw-77; NSF ATM-84-17880)
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The charging effects of a conducting/dielectric model spacecraft in the impact induced plasma environment are contrasted. The results of dynamic model calculations indicate larger charging times and higher positive spacecraft potentials for a conducting/dielectric spacecraft. The potential and particle distributions around the spacecraft differ quantitatively and qualitatively in both cases.
Author

**N87-26948#** Air Force Geophysics Lab., Hanscom AFB, Mass.
**COMPUTER MODELS OF THE SPACECRAFT WAKE**
M. Heinemann, A. Rubin, M. Tautz, and D. Cooke (RADEX, Inc., Carlisle, Mass.) *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 9 p (For primary document see N87-26937 21-18)
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The Mesothermal Auroral Charging (MACH) code, an inside-out particle tracking code, was developed for the purpose of validating the physics of the Potential Of Large Spacecraft in the Auroral Regions (POLAR) code in regimes where there can be no comprehensive theoretical or experimental results. While the spacecraft that can be treated by MACH are restricted to simple geometries, the methodology is more fundamental than POLAR. MACH generates self-consistent solutions within the context of quasisteady Vlasov plasma flow and achieves Debye ratios previously unobtainable. POLAR and MACH solutions are shown for the particle and electrostatic potential structure of the wake of a charged disk in a low altitude flow for Mach numbers 4, 5, and 8. The results of the codes are compared to each other and to simple analytic approximations as part of an effort to compute the nature of the spacecraft wake and to establish the validity of the codes.
Author

**N87-26949#** York Univ., Toronto (Ontario). Dept. of Physics.
**SPACECRAFT CHARGING IN THE AURORAL PLASMA: PROGRESS TOWARD UNDERSTANDING THE PHYSICAL EFFECTS INVOLVED**
J. G. Laframboise and L. W. Parker (Parker, Lee W., Inc., Concord, Mass ) *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 16 p (For primary document see N87-26937 21-18)
(Contract F19628-83-K-0028)
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The main differences between the plasma environments in geostationary orbit and low polar orbit with respect to high-voltage charging situations are reviewed. Results are presented from a calculation of secondary electron escape currents from negatively charged spacecraft surfaces having various orientations relative to the local magnetic field direction. A simple rough estimate of the required conditions for high-voltage auroral-zone charging is developed. The results suggest that for any given spacecraft, surface potentials are likely to depend more strongly on the ratio of ambient flux of high-energy electrons to that of all ions, than any other environmental parameter. Preliminary results of simulation work directed toward testing this hypothesis are presented.
Author

**N87-26950*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**SECONDARY ELECTRON GENERATION, EMISSION AND TRANSPORT: EFFECTS ON SPACECRAFT CHARGING AND NASCAP MODELS**

Ira Katz, Myron Mandell (Systems Science and Software, La Jolla, Calif.), James C. Roche, and Carolyn Purvis *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 12 p (For primary document see N87-26937 21-18)

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Secondary electrons control a spacecraft's response to a plasma environment. To accurately simulate spacecraft charging, the NASA Charging Analyzer Program (NASCAP) has mathematical models of the generation, emission and transport of secondary electrons. The importance of each of the processes and the physical basis for each of the NASCAP models are discussed. Calculations are presented which show that the NASCAP formulations are in good agreement with both laboratory and space experiments. Author

**N87-26951#** University Coll., London (England). Space Science Lab.

**SPACECRAFT CHARGING: METEOSAT EXPERIENCE**

G. L. Wrenn and A. D. Johnstone *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 14 p (For primary document see N87-26937 21-18)

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Operational problems with Meteosat 1 led to a collaborative effort to furnish subsequent spacecraft with simple charging monitors and to study the geosynchronous environment in an attempt to better understand the charging process. The electron spectrometer on Meteosat 2 has yielded a continuous 3-year data set which has clarified the role of plasma sheet electrons in the detailed current balance which controls spacecraft potentials. Continual observation of eclipse and partial shadowing features has illuminated the dominant role of photoelectrons and demonstrated that the safe clamping of differential voltages can be obtained. An electron albedo index has been developed as an aid to assessing spacecraft liability to charging. The majority of anomalies experienced by Meteosat 2 are not directly caused by charging, an alternative natural cause has not been found. Author

**N87-26952#** Toronto Univ. (Ontario). Dept. of Electrical Engineering.

**ARC PROPAGATION, EMISSION AND DAMAGE ON SPACECRAFT DIELECTRICS**

K. G. Balmain *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 7 p (For primary document see N87-26937 21-18)

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A review is given of the literature on the subject of arc discharges on spacecraft dielectric materials which have become charged by energetic electrons and ions. Arcs resulting from the charging of spacecraft dielectrics can be very strong because the charge over a large area is mobilized through the phenomenon of arc propagation. The resultant damage patterns on the dielectric are shown to be related to arc patterns, and to the optical anisotropy and crystallinity of the material. The evidence for dielectric melting is suggestive of likely contamination of nearby surfaces. The effectiveness of arc barriers sheds light on arc propagation mechanisms. Author

**N87-26953#** Centre d'Etudes et de Recherches, Toulouse (France). Dept. Technologie Spatiale.

**ON THE POSSIBILITY OF A SEVERAL-KILOVOLT DIFFERENTIAL CHARGE IN THE DAY SECTOR OF A GEOSYNCHRONOUS ORBIT [SUR LA POSSIBILITE DE CHARGE DIFFERENTIELLE DE PLUSIEURS KILOVOLTS DANS LE SECTEUR JOUR DE L'ORBITE GEOSYNCHRONE]**

L. Levy, D. Sarrail, J. P. Philippon, J. P. Catani, and J. M. Fourquet (MATRA Service Aerodynamique, Toulouse, France ) *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 12 p In FRENCH (For primary document see N87-26937 21-18)

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Day-sector charging events detected with the Telecom 1-A satellite were analyzed. The temporal distribution of the events, seasonal variations, and correlations with geomagnetic activity are discussed. In addition, several covering materials were subjected to quasi-monoenergetic electron bombardment in a simulation chamber. It was found that floating metallic surfaces, although small, produced enduring discharges with short rise times. M.G.

**N87-26954#** ERA Ltd., Leatherhead (England). Applied Physics Dept.

**RADIATION CHARGING AND BREAKDOWN OF INSULATORS** c33

D. K. Davies *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 7 p (For primary document see N87-26937 21-18)

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An experimental investigation of the charge produced by photo-emission from insulators in vacuo is described. It is shown that the emission from materials commonly used in spacecraft construction, such as polyimide, as well described by solid state theory, but that externally applied fields modify both the emission dynamics as well as the eventual saturation charge density. The energetics of the electric breakdown of such charged surfaces is analyzed. Author

**N87-26955#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany). Inst. fuer Hochfrequenztechnik.

**THE CURRENT AND FIELD DISTRIBUTION OF A HIGH POWER SATELLITE ANTENNA AFFECTED BY NONLINEAR PLASMA SHEATH PHENOMENA** c32

K.-H. Bethke and P. Edenhofer (Bochum Univ., West Germany ) *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 10 p Sponsored in part by Bundesministerium fuer Forschung und Technologie, West Germany (For primary document see N87-26937 21-18)

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For electromagnetic and acoustic radiation from antennas in a plasma environment, the fundamental electro- and hydrodynamic equations are presented involving nonlinear source terms up to the third order. A perturbation procedure is applied to derive a numerical solution from a set of coupled integral equations for the linearized (first order) magnetic field and electron density describing the dipole radiation into a homogeneous compressible plasma. The solution is given in terms of an equivalent surface current density based on a Green's function representation. An inhomogeneous plasma sheath is shown to build up around the dipole, where the antenna-to-plasma coupling turns out to be strongest in the near field of a high power transmitting antenna. Author

**N87-26956#** Societe Nationale Industrielle Aerospatiale, Cannes (France).

**SPACECRAFT PROTECTION AGAINST ELECTROSTATIC DISCHARGE APPLICATION TO THE ARABSAT SPACECRAFT**

Laurent Broihanne *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 11 p (For primary document see N87-26937 21-18)

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The protections against electrostatic discharge (ESD) phenomena effects which were implemented on the ARABSAT spacecraft are summarized. The origins of ESD phenomena on geostationary spacecraft are recalled. The basic design rules

concerning ESD which were applied to ARABSAT are given.
Author

**N87-26957#** European Space Agency. European Space Research and Technology Center, ESTEC, Noordwijk (Netherlands). Community Satellites Dept.
**ELECTROSTATIC IMMUNITY OF GEOSTATIONARY SATELLITES**
Horst G. Lechte *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 8 p (For primary document see N87-26937 21-18)
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It is demonstrated that electrostatic immunity of telecommunication satellites can be achieved to a large extent by relatively simple means. Those means include the selection of antistatic external materials and the desensitization of electronic actuators and memories regarding fast transients. The dual approach is considered necessary because not all external surfaces can be made antistatic. Protection of operationally critical circuitries against single event upsets is achieved by the same means.
Author

**N87-26958#** Telesat Canada, Ottawa (Ontario). Satellite Engineering Group.
**THE EFFECTS OF ELECTROSTATIC DISCHARGE PHENOMENA ON TELESAT'S DOMESTIC COMMUNICATIONS SATELLITES**
P. N. Wadham *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 10 p (For primary document see N87-26937 21-18)
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A number of anomalies believed to have been caused by electrostatic discharges are discussed. In particular, an unusually severe event which resulted in a temporary loss of control and a consequent loss of fuel is discussed. Each class of satellite is covered in sequence by launch date. Mention is made of the configuration of the thermal blankets because they are considered to be the prime cause of electrostatic discharges. Author

**N87-26959#** Atomic Energy Research Establishment, Harwell (England).
**SURFACE MODIFICATION TO MINIMISE THE ELECTROSTATIC CHARGING OF KAPTON IN THE SPACE ENVIRONMENT** c33
D. Verdin and M. J. Duck *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 12 p Sponsored in part by the Royal Aircraft Establishment, Farnborough, England (For primary document see N87-26937 21-18)
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The electrostatic charging of Kapton under electron irradiation is reduced by coating it with a dispersion of indium oxide in a soluble polyimide. The proportion of oxide in the coating and its thickness are chosen to give an optimum balance between the surface resistivity and the thermo-optical properties of the film.
Author

**N87-26960#** Air Force Geophysics Lab., Hanscom AFB, Mass.
**AUTOMATIC CHARGE CONTROL SYSTEM FOR GEOSYNCHRONOUS SATELLITES**
B. M. Shuman, H. A. Cohen, J. Hyman, R. R. Robson, J. Santoru, and W. S. Williamson (Hughes Research Labs., Malibu, Calif.) *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 17 p (For primary document see N87-26937 21-18)
Copyright Avail: NTIS HC A13/MF A01

An autonomous system to detect both absolute and differential spacecraft charging aboard high altitude satellites and to reduce those potentials before hazardous arcing levels are reached is being developed. The principle of safely reducing spacecraft charging levels by the emission of a low energy neutral plasma, effectively shorting the spacecraft and charged dielectric surfaces to the ambient space plasma, was demonstrated. The Charge Control System will utilize a xenon-based plasma source capable of igniting within one second, and capable of emmiting a quasi-neutral plasma containing more than 1 mA of ions. Author

**N87-26961#** Aerospace Corp., Los Angeles, Calif. Space Sciences Lab.
**THICK DIELECTRIC CHARGING ON HIGH ALTITUDE SPACECRAFT**
A. L. Vampola *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 7 p Previously announced as N87-13480 (For primary document see N87-26937 21-18)
(Contract F04701-82-C-83)
Copyright Avail: NTIS HC A13/MF A01

Thick dielectric charging, in which energetic electrons embed within bulk dielectrics and build up to potentials in excess of the breakdown potential of the dielectric, is shown to be a causitive factor in the anomalous operation of high altitude satellites. Results of laboratory studies are reviewed and a table of maximum expected electron fluxes orbits of various altitudes is presented. The combination of maximum expected electron fluxes and the small energy associated with a bulk dielectric breakdown permits the elimination of bulk charging as a spacecraft problem through the minimum shielding (400 mg/sq cm) of all cables and circuit boards otherwise exposed to the environment, and through the desensitizing of digital logic inputs that are serviced by cables.
Author

**N87-26962#** Air Force Geophysics Lab., Hanscom AFB, Mass.
**POLAR-AURORAL CHARGING OF THE SPACE SHUTTLE AND EVA ASTRONAUT** c16
William N. Hall, Philip Leung, Ira Katz, Gary A. Jongeward, John R. Lilley, Jr., Joseph E. Nanevicz, Jeffrey S. Thayer, and N. John Stevens (TRW, Inc., Redondo Beach, Calif.) *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 9 p (For primary document see N87-26937 21-18)
Copyright Avail: NTIS HC A13/MF A01

The evidence indicates that an astronaut carrying out extra-vehicular activity (EVA) in the Shuttle wake in polar orbit could have his EVA equipment charge up to significant voltages if an intense aurora is encountered. Arc discharges are expected to occur that are similar to those that have caused system upsets and failures in geosynchronous orbits. The possibility of hazard to the astronauts must be evaluated quickly, since polar orbit Shuttle launches will soon begin.
Author

**N87-26963#** Iowa State Univ. of Science and Technology, Ames. Engineering Research Inst.
**DYNAMIC SIMULATION OF SPIN-STABILIZIED SPACECRAFT WITH SLOSHING FLUID STORES Annual Technical Report, 1 Jan. - 31 Dec. 1986**
Daniel E. Hill, Joseph R. Baumgarten, and John T. Miller 31 Dec. 1986 40 p
(Grant AF-AFOSR-0080-86)
(AD-A180688; ISU-ERI-AMES-86451; AFOSR-87-0639TR) Avail: NTIS HC A03/MF A01 CSCL 20D

Launching of several of the Star 48 Communications Satellites from the Space Shuttle have consistently resulted in a nutating motion of the spacecraft. Sloshing fluid stores have been suspected as a source of dynamic instability. A mathematical model of the sloshing fluid motion coupled with the satellite dynamics was developed and the launch phase simulated. The flight simulation showed similar behavior when compared to the telemetered flight data.
GRA

**N87-26964#** Army War Coll., Carlisle Barracks, Pa.
**MILITARY SPACE STATION IMPLICATIONS**
Garrett D. Bourne, Glen D. Skirvin, and Gerald R. Wilson 23 Mar. 1987 186 p
(AD-A180831) Avail: NTIS HC A09/MF A01 CSCL 22B

The relevancy of a Manned Military Space Station (MMSS) and its deployment to capitalize on the United States' national

security interests is the purpose of this report. The MMSS is intended to perform a two-fold purpose: (1) facilitate military peacetime operations while simultaneously supporting and promoting civilian space initiatives; and, (2) act as a force multiplier for space and terrestrial force operations in the event of conventional, theater nuclear, and/or strategic nuclear war. Data to support the future value of the MMSS was obtained from individual and group research using unclassified sources such as professional journals, books, US Air Force Staff College reference material, and information from the US Air Force space coordinating staff in Washington, D.C. The importance of space to our future and especially of a MMSS by America's national leaders and its people has yet to be fully appreciated and/or realized. The significance of space and its nexus to the United States' national security has been growing in importance since Sputnik in 1957. Space cannot and should not be understated in importance as it relates to commerce, war deterrence, and to the stability of world order. GRA

**N87-26965#** Systems Science and Software, La Jolla, Calif.
**ANALYTIC AND OBSERVATIONAL APPROACHES TO SPACECRAFT AURORAL CHARGING**
T. G. Barker Nov. 1986 47 p
(Contract F19628-86-C-0056)
(AD-A181456; SSS-R-87-8377; AFGL-TR-87-0021; SR-1) Avail: NTIS HC A03/MF A01 CSCL 22A

The objective of this report is to present a set of computational tools which can be used to process large quantities of observations of auroral electron and ion fluxes to yield estimates of the likelihood of spacecraft charging. The tools and procedures would be tested on observations of environments and spacecraft charging, and then be used to predict the levels of charging for the shuttle in polar orbits. We have presented two approaches. The first approach is to fit the observed spectra to analytic functions which can then be manipulated to find the charging potential. The analytic functions proposed by Fontheim, et al., (1985), to represent electron flux spectra, are parameterized by a set of observable physical parameters. The second approach is to numerically integrate the observations directly. The second approach is more appropriate for large numbers of spectra, while the first provides physical parameters which give insight into the nature of the precipitating electron environment. The appendix of this report is a user's manual for the computer programs which perform these tasks. GRA

**N87-26966#** Naval Postgraduate School, Monterey, Calif.
**DYNAMIC ANALYSIS OF THE FLEXIBLE BOOM IN THE N-ROSS SATELLITE M.S. Thesis**
Choong S. Kang Mar. 1987 149 p
(AD-A181488) Avail: NTIS HC A07/MF A01 CSCL 22A

Accurate ocean data is essential for successful fleet operation. The N-ROSS Satellite, which is being developed for this mission, will carry a Low Frequency Microwave Radiometer (LFMR). The LFMR consists of large flexible reflector and boom and spins at 15 r.p.m. The effects of the flexibility of the boom, the spin-up procedure and the structural damping on the pointing error of the LFMR are investigated by performing the dynamic simulation using the Dynamic Simulation Language. Two cases of boom material, aluminum alloy and the graphite/epoxy composite material, are analyzed and the results are compared. The simulation and analysis results are presented in graphical forms. Author (GRA)

**N87-26967#** Systems Science and Software, La Jolla, Calif.
**DOCUMENTATION FOR THE SHADO PARTICLE WAKE ROUTINE Technical Report, Oct. 1986 - Jan. 1987**
D. L. Peterka and I. Katz Jan. 1987 25 p
(Contract F19668-86-C-0056)
(AD-A181531; SSS-R-87-8495; AFGL-TR-87-0042; SR-5) Avail: NTIS HC A02/MF A01 CSCL 22B

This report documents the computational algorithms of the SHADO routine for computing the particle wake behind large spacecraft in low polar orbit. SHADO will replace the existing module for computing particle densities in the POLAR code and achieves a significant improvement in computational speed. GRA

**N87-26968#** Naval Postgraduate School, Monterey, Calif.
**COMPUTER SIMULATION OF A ROTATIONAL SINGLE-ELEMENT FLEXIBLE SPACECRAFT BOOM M.S. Thesis**
Robert S. Laufenberg Mar. 1987 91 p
(AD-A181798) Avail: NTIS HC A05/MF A01 CSCL 22B

The requirement to develop a space based remote ocean sensing platform exists within the Department of the Navy. This project models a satellite subsystem with structural flexibility utilizing the Equivalent Rigid Link System (ERLS). Dynamic analysis with computer simulation is presented for a simple flexible boom rotating in three dimensions with and without a point mass at the boom tip. Author (GRA)

**N87-26969#** Oak Ridge National Lab., Tenn.
**EFFECTS OF DIRECTED AND KINETIC ENERGY WEAPONS ON SPACECRAFT**
A. P. Fraas Dec. 1986 75 p
(Contract DE-AC05-84OR-21400)
(DE87-006015; ORNL/TM-9814) Avail: NTIS HC A04/MF A01

The characteristics of the various directed energy beams are reviewed, and their damaging effects on typical materials are examined for a wide range of energy pulse intensities and durations. Representative cases are surveyed, and charts are presented to indicate regions in which damage to spacecraft structures, particularly radiators for power plants, would be likely. The effects of kinetic energy weapons, such as bird-shot, are similarly examined. The charts are then applied to evaluate the effectiveness of various measures designed to reduce the vulnerability of spacecraft components, particularly nuclear electric power plants. DOE

**N87-26970** Virginia Univ., Charlottesville.
**THEORY AND APPLICATION OF LINEAR SERVO DAMPERS FOR LARGE SCALE SPACE STRUCTURES Ph.D. Thesis**
Michael Frederick Mallette 1986 244 p
Avail: Univ. Microfilms Order No. DA8705681

An investigation was made of control laws of several different servo control circuits for use in damping the vibrations of large scale space structures. A proof-mass type, structure-borne displacement device was tested as a linear servo actuator that is a component of digital control systems. These systems are hardware implementations of certain mathematical models of governing equations that show higher damping figures of merit for certain control circuits in regard to stability and response. The result was a general approach to removal of structural energy from the standpoint of design criterion that includes control law shaping predicted from open loop design, frequency limitations, and selectability of integral exponents as gain values. The critical elements in the development of the damper are the electronic digital signal processor and the associated software used to boot-strap the system up to the final Z-80 microprocessor ground based simulator, and the nearly pure iron pole pieces for the toroidal magnetic field containment into which is coupled a solenoid coil to produce control forces. Dissert. Abstr.

**N87-26971#** General Accounting Office, Washington, D. C. National Security and International Affairs Div.
**WEATHER SATELLITES: ECONOMIES AVAILABLE BY CONVERGING GOVERNMENT METEOROLOGICAL SATELLITES**
Apr. 1987 78 p
(PB87-186623; GAO/NSIAD-87-107; B-223632) Avail: NTIS HC A05/MF A01 CSCL 22B

The United States operates two separate, but similar, polar orbiting meteorological satellite systems. The need for separate systems has been an issue since the early 1970s. Interagency studies have concluded that the two systems should be consolidated into one program or at least converged to a greater degree. Several hundred million dollars in cost savings may be

possible. GAOs objective was to determine if the two satellite systems could be converged to eliminate duplicative practices and overlapping functions, and still provide necessary services to the system's users. GRA

**N87-26972#** Intespace, Toulouse (France).
**MECHANICAL TEST DATA EVALUATION FOR ENVIRONMENTAL TEST SPECIFICATIONS Final Report**
A. Girard, A. Ayral, H. Defosse, and M. Pawlowski Paris, France ESA 18 Apr. 1986 241 p
(Contract ESTEC-6236/85-NL-PP(SC))
(Rept-86.596.EI/ET/AG/GG; ESA-CR(P)-2326; ETN-87-99981)
Copyright Avail: NTIS HC A11/MF A01

In order to improve European specifications for sine and random testing at unit level by statistical analysis on measured test data, a data base was prepared from sine, random, and acoustic test results at system level. Seven European satellite projects provided 1500 response curves. The data base was normalized for sampling, reference axes, and reference environments corresponding to an envelope of the Ariane 4 and shuttle requirements for qualification. For the random and acoustic test results, Random Response Spectrum (RRS), reflecting the damage potential of a given Power Spectral Density (PSD) was used. A statistical evaluation was made using the acceleration amplitudes for the sine test results and the acceleration RRS for the PSD results, based on a log normal distribution. Curves were selected using the parameters in the data base. The final equipment classification was deduced from these results. The corresponding specifications were derived by considering a confidence level of 95%. ESA

# 19 SPACECRAFT INSTRUMENTATION

For related information see also *06 Aircraft Instrumentation* and *35 Instrumentation and Photography.*

No abstracts in this category.

# 20 SPACECRAFT PROPULSION AND POWER

Includes main propulsion systems and components, e.g., rocket engines; and spacecraft auxiliary power sources.

For related information see also *07 Aircraft Propulsion and Power, 28 Propellants and Fuels, 44 Energy Production and Conversion,* and *15 Launch Vehicles and Space Vehicles.*

**N87-26973*#** Christopher Newport Coll., Newport News, Va. Dept. of Physics.
**[INVESTIGATION OF THE ACOUSTIC PROPERTIES OF COMPOSITE MATERIALS] Semiannual Report, 1 Nov. 1986 - 30 Apr. 1987**
B. T. Smith 1987 42 p
(Grant NAG1-431)
(NASA-CR-180975; NAS 1.26:180975) Avail: NTIS HC A03/MF A01 CSCL 21H

An effort to provide inspection of the bondlines in the Space Shuttle Solid Rocket Motor (SRM) is discussed. Investigation of the bondlines in the membrane region of the SRM has centered on representative samples provided by Morton Thiokol. These samples have pull-tabs, or in one case grafoil inserts, to simulate delaminations at various points in the multilayer structure of steel case, liner, insulation, liner, and propellant. Discussed here is the continuing approach to examining these defects which is predicated on a model of an ultrasonic wave propagating in a lossy multilayer resonant structure, the experimental arrangements used, and the results of these experiments. Author

**N87-26974#** TRW Space Technology Labs., Redondo Beach, Calif. Applied Technology Div.
**PULSED INDUCTIVE THRUSTER COMPONENT TECHNOLOGY Final Report, 1 Oct. 1982 - 31 Oct. 1986**
C. L. Dailey and R. H. Lovberg Apr. 1987 83 p
(Contract F04611-82-C-0058)
(AD-A181068; AFAL-TR-87-012) Avail: NTIS HC A05/MF A01 CSCL 21C

The pulsed inductive thruster (PIT) is an electrical propulsion device that accelerates a plasma propellant by the JxB Lorentz force, and in which the driving current in the plasma is induced, rather than being introduced through electrodes. This program addressed: thruster circuit component design; plasma probe diagnostics and thrust balance measurements for two of the three thruster designs developed during the program; design of a flight-type capacitor; capacitor pad life testing; and demonstration of the system in the clamped discharge mode. A numerical simulation of thruster operation was developed and used to elucidate the effects on efficiency of circuit parameters, plasma conductivity and scale size. Capacitor tests results indicated very long life is obtainable wih modest voltage derating using paper/polypropylene capacitors. Development of a successful scheme for high power, high frequency diode clamping has made it possible to operate without significant capacitor voltage reversal, and hence to extend capacitor life by up to two orders of magnitude. A life demonstration of the propellant injection valve exceeded the goal one million cycles; however, a rotary device may be better suited. GRA

# 23 CHEMISTRY AND MATERIALS (GENERAL)

No abstracts in this category.

# 24 COMPOSITE MATERIALS

Includes physical, chemical, and mechanical properties of laminates and other composite materials.

For ceramic materials see *27 Nonmetallic Materials.*

**N87-26975*#** Georgia Inst. of Tech., Atlanta. School of Mechanical Engineering.
**MODELING OF TRANSIENT HEAT PIPE OPERATIONS Semiannual Report, 19 Feb. - 18 Aug. 1986**
Gene T. Colwell and James G. Hartley 1 Nov. 1986 42 p
(Grant NAG1-392)
(NASA-CR-180286; NAS 1.26:180286) Avail: NTIS HC A03/MF A01 CSCL 20D

An analysis of the steady, compressible, one-dimensional, laminar flow of sodium vapor is presented for a case of a flat plate-type heat pipe with asymmetrical boundary conditions. In addition, shear stress at the liquid-vapor interface, variations of vapor quality, and momentum and energy factors are considered. A similarity solution for a semiporous channel is used to provide the velocity profile at cross sections. Author

**N87-26976*#** North Carolina State Univ., Raleigh. Dept. of Physics.
**EFFECTS OF HIGH ENERGY RADIATION ON THE MECHANICAL PROPERTIES OF EPOXY/GRAPHITE FIBER REINFORCED COMPOSITES Interim Report, 1 Jan. - 31 Oct. 1986**
R. E. Fornes, R. D. Gilbert, and J. D. Memory 31 Oct. 1986 167 p
(Grant NsG-1562)
(NASA-CR-180310; NAS 1.26:180310) Avail: NTIS HC A08/MF A01 CSCL 11D

The epoxy resin system formed by tetraglycidyl 4,4'-diamino diphenyl methane (TGDDM) and 4,4'-diamino diphenyl sulfone (DDS) was characterized by dynamic mechanical analysis and differential scanning calorimetry. Dynamic mechanical properties of graphite fiber epoxy composite specimens formulated with two different adhesive systems (NARMCO 5208, NARMCO 5209) were determined. The specimens were exposed to varying dose levels of ionizing radiation (0.5 MeV electrons) with a maximum absorbed dose of 10,000 Mrads. Following irradiation, property measurements were made to assess the influence of radiation on the epoxy and composite specimens. The results established that ionizing radiation has a limited effect on the properties of epoxy and composite specimens. Author

**N87-26977*#** Texas A&M Univ., College Station. Dept. of Mechanical Engineering.
**MICROMECHANICS OF COMPOSITE LAMINATE COMPRESSION FAILURE Semiannual Progress Report, period ending 1 Nov. 1986**
E. Gail Guynn and Walter L. Bradley 15 Nov. 1986 37 p
(Grant NAG1-659)
(NASA-CR-180348; NAS 1.26:180348) Avail: NTIS HC A03/MF A01 CSCL 11D

The Dugdale analysis for metals loaded in tension was adapted to model the failure of notched composite laminates loaded in compression. Compression testing details, MTS alignment verification, and equipment needs were resolved. Thus far, only 2 ductile material systems, HST7 and F155, were selected for study. A Wild M8 Zoom Stereomicroscope and necessary attachments for video taping and 35 mm pictures were purchased. Currently, this compression test system is fully operational. A specimen is loaded in compression, and load vs shear-crippling zone size is monitored and recorded. Data from initial compression tests indicate that the Dugdale model does not accurately predict the load vs damage zone size relationship of notched composite specimens loaded in compression. Author

**N87-26978*#** Washington Univ., St. Louis, Mo. Dept. of Physics.
**QUANTITATIVE NON-DESTRUCTIVE EVALUATION OF COMPOSITE MATERIALS BASED ON ULTRASONIC PARAMETERS Semiannual Progress Report, 15 Sep. 1986 - 15 Mar. 1987**
James G. Miller Mar. 1987 20 p
(Grant NsG1-601)
(NASA-CR-180629; NAS 1.26:180629) Avail: NTIS HC A02/MF A01 CSCL 11D

Research into the nondestructive evaluation of advanced reinforced composite laminates is summarized. The applicability of the Framers-Kronig equations to the nondestructive evaluation of composite materials is described. B.G.

**N87-26979*#** Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Adhesion Science.
**SURFACE CHARACTERIZATION IN COMPOSITE AND TITANIUM BONDING Semiannual Report, 1 Apr. - 30 Sep. 1986**
T. A. DeVilbiss and J. P. Wightman Dec. 1986 39 p
(Grant NAG1-343)
(NASA-CR-180637; NAS 1.26:180637; CAS/CHEM-13WI-86; Rept-96) Avail: NTIS HC A03/MF A01 CSCL 11D

The failure surface analysis of adhesively bonded carbon fiber composites is described. The emphasis is on the bonding of composites when the surface has been made intentionally resin-rich. Also discussed is surface analysis of both commercially available and pretreated carbon fibers. The interaction of the fibers with polysulfone is described. Author

**N87-26980*#** North Carolina State Univ., Raleigh. Dept. of Physics.
**EFFECTS OF HIGH ENERGY RADIATION ON THE MECHANICAL PROPERTIES OF EPOXY/GRAPHITE FIBER REINFORCED COMPOSITES Final Technical Report**
R. E. Fornes, R. D. Gilbert, and J. D. Memory Jul. 1987 65 p
(Grant NsG-1562)
(NASA-CR-181110; NAS 1.26:181110) Avail: NTIS HC A04/MF A01 CSCL 11D

Publications and theses generated on composite research are listed. Surface energy changes of an epoxy based on tetraglycidyl diaminodiphenyl methane (TGDDM)/diaminodiphenyl sulfone (DDS), T-300 graphite fiber and T-300/5208 (graphite fiber/epoxy) composites were investigated after irradiation with 0.5 MeV electrons. Electron spin resonance (ESR) investigations of line shapes and the radical decay behavior were made of an epoxy based on tetraglycidyl diaminodiphenyl methane (TGDDM)/diaminodiphenyl sulfone (DDS), T-300 graphite fiber, and T-300/5208 (graphite fiber/epoxy) composites after irradiation with Co(60) gamma-radiation or O.5 MeV electrons. The results of the experiments are discussed. B.G.

**N87-26981** ESDU International Ltd., London (England).
**FAILURE ANALYSIS OF FIBRE-REINFORCED LAMINATES (COMPUTER PROGRAM)**
Sep. 1984 72 p
(ESDU-84018; ISBN-0-85679-480-5; ISSN-0141-4097) Avail: ESDU

ESDU 84018 gives a FORTRAN program for failure analysis of the laminate subjected to consecutive systems of combined in-plane, moment and thermal loading. Initially unconstrained balanced or unbalanced laminates can be treated, as can the effect of holding the unloaded laminate flat. The failure assessment is based on a linear elastic layer-by-layer analysis in which the stresses in each layer in turn are compared to the Puck Modified Criterion (see also ESDU 83014) which differentiates between fiber and matrix failures. If matrix failure occurs, the transverse direct and shear stiffnesses of that layer are put to zero but the fiber stiffness properties are retained. The development of such layer failures is traced under the gradual application of the loading system to provide a damage history. Laminate failure is assumed either when total matrix failure occurs or when fiber-failure in one layer occurs. If failure does not occur, the program provides an assessment of the load level that would cause failure. ESDU

**N87-26982#** MSNW, Inc., San Marcos, Calif.
**PLASMA JOINING OF METAL MATRIX COMPOSITES Interim Technical Report, Aug. - Sep. 1986**
G. H. Reynolds and L. Yang Mar. 1987 8 p
(Contract DAAG29-85-C-0027)
(AD-A181056; ARO-22817.5-MS-S) Avail: NTIS HC A02/MF A01 CSCL 11D

Optical metallographic examinations of weld metal and heat affected zone microstructures of butt welds produced in 6061 Al-30% SiC sub p composite plates using the low pressure, transferred arc plasma welding process with composite powder filler metals are described. GRA

**N87-26983#** Boston Univ., Mass. Dept. of Physics.
**INVESTIGATION OF THE ELECTRIC AND MAGNETIC PROPERTIES OF INTERCALATED GRAPHITES Final Report, 30 Sep. 1982 - 29 Sep. 1986**
G. O. Zimmerman 1987 161 p
(Grant AF-AFOSR-0286-82)
(AD-A181481; AFOSR-87-0418TR) Avail: NTIS HC A08/MF A01 CSCL 11D

The picture which emerges from our investigations is that we are indeed observing the behavior of a two dimensional magnetic system. The low dimensionality is brought about by the shielding of the intercalant layers by the intervening graphite layers. The shielding also depends on the charge transfer between the intercalant and the graphics. In graphite there is a band near K = O about half filled with electrons (10). The intercalation of an acceptor compound will draw off those electrons so that the electrical conduction is hole-like. Thus low stages exhibit a positive Hall coefficient. The shielding of the intercalant layers is due to electromagnetic shielding analogous to the skin effect, where the skin depth is a function of the electrical conductivity, which in

turn is a function of the number of charge carriers. Stages 1 to 5 almost empty the band of electrons and thus the graphite layers have maximum conductivity. Above stage 5, the quantity of acceptors is not large enough to absorb all the electrons which can be donated by the graphite, and the conductivity of the graphite layers decreases. Moreover, the conductivity, according to our Hall measurements, is due to both positive and negative carriers.
GRA

**N87-26984*#** Clemson Univ., S.C. Dept. of Mechanical Engineering.
**DAMAGE GROWTH IN COMPOSITE LAMINATES WITH INTERLEAVES Annual Report**
James G. Goree 15 Aug. 1987 112 p
(Grant NAG1-629)
(NASA-CR-181211; NAS 1.26:181211) Avail: NTIS HC A06/MF A01 CSCL 11D

The influence of placing interleaves between fiber reinforced plies in multilayered composite laminates is investigated. The geometry of the composite is idealized as two dimensional, isotropic, linearly elastic media made of a damaged layer bonded between two half planes and separated by thin interleaves of low extensional and shear moduli. The damage in the layer is taken in the form of a symmetric crack perpendicular to the interface and may extend up to the interface. The case of an H-shaped crack in the form of a broken layer with delamination along the interface is also analyzed. The interleaves are modeled as distributed shear and tension springs. Fourier integral transform techniques are used to develop solutions in terms of singular integral equations. An asymptotic analysis of the integral equations based on Muskhelishvili's techniques reveals logarithmically singular axial stresses in the half plane at the crack tips for the broken layer. For the H shaped crack, similar singularities are found to exist in the axial stresses at the interface crack tips in the layer and the half plane. The solution of the equations is found numerically for the stresses and displacements by using the Hadamard's concept of direct differentiation of Cauchy integrals as well as Gaussian integration techniques. Author

**N87-26985*#** Virginia Polytechnic Inst. and State Univ., Blacksburg. Center for Composite Materials and Structures.
**AN ANALYTICAL AND EXPERIMENTAL STUDY OF CRACK EXTENSION IN CENTER-NOTCHED COMPOSITES Interim Report No. 61**
Jack L. Beuth, Jr. and Carl T. Herakovich Jul. 1987 236 p Sponsored in part by Hercules, Inc., Magna, Utah and Center for Innovative Technology, Herndon, Va.
(Grant NAG1-343)
(NASA-CR-180287; NAS 1.26:180287; CCMS-87-09; VPI-E-87-10) Avail: NTIS HC A11/MF A01 CSCL 11D

The normal stress ratio theory for crack extension in anisotropic materials is studied analytically and experimentally. The theory is applied within a microscopic-level analysis of a single center notch of arbitrary orientation in a unidirectional composite material. The bulk of the analytical work of this study applies an elasticity solution for an infinite plate with a center line to obtain critical stress and crack growth direction predictions. An elasticity solution for an infinite plate with a center elliptical flaw is also used to obtain qualitative predictions of the location of crack initiation on the border of a rounded notch tip. The analytical portion of the study includes the formulation of a new crack growth theory that includes local shear stress. Normal stress ratio theory predictions are obtained for notched unidirectional tensile coupons and unidirectional Iosipescu shear specimens. These predictions are subsequently compared to experimental results. Author

**N87-26986*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**INTERLAMINAR SHEAR FRACTURE TOUGHNESS AND FATIGUE THRESHOLDS FOR COMPOSITE MATERIALS**
T. Kevin OBrien, Gretchen B. Murri, and Satish A. Salpekar (Analytical Services and Materials, Inc., Hampton, Va.) Aug. 1987 68 p Prepared in cooperation with Army Aviation Research and Development Command, Hampton, Va.
(DA Proj. 1L1-61102-AH-45C)
(NASA-TM-89157; NAS 1.15:89157; USAAVSCOM-TM-87-B-9) Avail: NTIS HC A04/MF A01 CSCL 11D

Static and cyclic end notched flexure tests were conducted on a graphite epoxy, a glass epoxy, and graphite thermoplastic to determine their interlaminar shear fracture toughness and fatigue thresholds for delamination in terms of limiting values of the mode II strain energy release rate, G-II, for delamination growth. The influence of precracking and data reduction schemes are discussed. Finite element analysis indicated that the beam theory calculation for G-II with the transverse shear contribution included was reasonably accurate over the entire range of crack lengths. Cyclic loading significantly reduced the critical G-II for delamination. A threshold value of the maximum cyclic G-II below which no delamination occurred after one million cycles was identified for each material. Also, residual static toughness tests were conducted on glass epoxy specimens that had undergone one million cycles without delamination. A linear mixed-mode delamination criteria was used to characterize the static toughness of several composite materials; however, a total G threshold criterion appears to characterize the fatigue delamination durability of composite materials with a wide range of static toughness. Author

**N87-26987#** Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
**LAMINATE STIFFNESSES AND CLASSICAL LAMINATE THEORY**
J. W. Gunnink Nov. 1985 10 p
(VTH-LR-477; B8707450; ETN-87-90216) Avail: NTIS HC A02/MF A01

A method by which the stiffness properties of a combined laminate can be calculated directly from the known stiffnesses of two individually symmetric laminates making up this combined laminate was extended to the general case of stacking an unrestricted number of laminates of entirely general properties. It is shown that the stiffness matrices of the combined laminate can be expressed in terms of the stiffness matrices of the individual laminates. It is found that the classical laminate theory can be extended and put in more general terms. It is possible to select laminates with special properties, that are not otherwise apparent.
ESA

**N87-26988*#** Georgia Inst. of Tech., Atlanta. Center for Rotary Wing Aircraft Technology.
**ANALYSIS, DESIGN AND ELASTIC TAILORING OF COMPOSITE ROTOR BLADES Final Report, 12 Feb. 1986 - 11 Aug. 1987**
Lawrence W. Rehfield and Ali R. Atilgan Sep. 1987 28 p
(Grant NAG1-638)
(NASA-CR-181234; NAS 1.26:181234) Avail: NTIS HC A03/MF A01 CSCL 11D

The development of structural models for composite rotor blades is summarized. The models are intended for use in design analysis for the purpose of exploring the potential of elastic tailoring. The research was performed at the Center for Rotary Wing Aircraft Technology. For individual titles, see N87-26989 through N87-26990.

**N87-26989*#** Georgia Inst. of Tech., Atlanta. Center for Rotary Wing Aircraft Technology.
**A STRUCTURAL MODEL FOR COMPOSITE ROTOR BLADES AND LIFTING SURFACES**
Lawrence W. Rehfield and Ali R. Atilgan *In its* Analysis, Design and Elastic Tailoring of Composite Rotor Blades Sep. 1987 11 p (For primary document see N87-26988 21-24)
(Contract DAAS29-82-K-0097)
Avail: NTIS HC A03/MF A01 CSCL 11D

Composite material systems are currently candidates for aerospace structures, primarily for the design flexibiity they offer i.e., it is possible to tailor the material and manufacturing approach to the application. Two notable examples are the wing of the Grumman/USAF/DARPA X-29 and rotor blades under development by the U.S.A. Aerostructures Directorate (AVSCOM), Langley

Research Center. A working definition of elastic or structural tailoring is the use of structural concept, fiber orientation, ply stacking sequence, and a blend of materials to achieve specific performance goals. In the design process, choices of materials and dimensions are made which produce specific response characteristics which permit the selected goals to be achieved. Common choices for tailoring goals are preventing instabilities or vibration resonances or enhancing damage tolerance. An essential, enabling factor in the design of tailored composite structures is structural modeling that accurately, but simply, characterizes response. The objective of this paper is to improve the single-cell beam model for composite rotor blades or lifting surfaces and to demonstrate its usefullness in applications. Author

**N87-26990*#** Georgia Inst. of Tech., Atlanta. Center for Rotary Wing Aircraft Technology.
**STRUCTURAL MODELING FOR MULTICELL COMPOSITE ROTOR BLADES**
Lawrence W. Rehfield and Ali R. Atilgan *In its* Analysis, Design and Elastic Tailoring of Composite Rotor Blades Sep. 1987 11 p (For primary document see N87-26988 21-24)
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**N87-26991*#** Materials Sciences Corp., Spring House, Pa.
**ANALYSIS OF WOVEN FABRICS FOR REINFORCED COMPOSITE MATERIALS Final Report, 3 Nov. 1982 - 30 Apr. 1987**
Norris F. Dow, V. Ramnath, and B. Walter Rosen Apr. 1987 239 p
(Contract NAS1-17205)
(NASA-CR-178275; NAS 1.26:178275; MSC-TFR-1715/0210)
Avail: NTIS HC A11/MF A01 CSCL 11D

The use of woven fabrics as reinforcements for composites is considered. Methods of analysis of properties are reviewed and extended, with particular attention paid to three-dimensional constructions having through-the-thickness reinforcements. Methodology developed is used parametrically to evaluate the performance potential of a wide variety of reinforcement constructions including hybrids. Comparisons are made of predicted and measured properties of representative composites having biaxial and triaxial woven, and laminated tape lay-up reinforcements. Overall results are incorporated in advanced weave designs. Author

# 25 INORGANIC AND PHYSICAL CHEMISTRY

Includes chemical analysis, e.g., chromatography; combustion theory; electrochemistry; and photochemistry.

For related information see also *77 Thermodynamics and Statistical Physics.*.

**N87-26992*#** Joint Inst. for Lab. Astrophysics, Boulder, Colo.
**INNOVATIVE METHODS FOR THE MEASUREMENT OF I* QUANTUM YIELDS AND KINETICS BY DIODE LASER GAIN-VERSUS-ABSORPTION Final Report, 1 Jul. 1985 - 30 Jun. 1987**
Stephen R. Leone 30 Jun. 1987 7 p
(Grant NAG1-600)
(NASA-CR-180999; NAS 1.26:180999) Avail: NTIS HC A02/MF A01 CSCL 07D

The quantum yields of a variety of candidate molecules for solar lasant materials to produce I* were tested. The absorption spectrum was measured for each compound and the I* yield determined by the diode laser or by infrared emission, using C3F7I as a standard. The results of these measurements are summarized. A GaAsInP diode laser system was developed to probe I and I* atoms to obtain yields and kinetics. A technique of gain-versus-absorption spectroscopy was investigated to measure quantum yields with high accuracy. The errors in the yield data were reduced to +/- 2% or less. In addition, experiments were set up to measure the rates of F-sublevel changing collisions in both the I ground state and the I* excited state. Finally, experiments and modelling were carried out to explore the possibility of measuring the recombination rates of I* with C3F7 radicals.
M.G.

**N87-26993** ESDU International Ltd., London (England).
**THERMAL CONDUCTIVITY OF LIQUID AROMATIC HYDROCARBONS CONTAINING OXYGEN**
Aug. 1984 1 p Supersedes ESDU-74032
(ESDU-84019; ESDU-74032; ISBN-0-85679-483-X; ISSN-0141-4062) Avail: ESDU

ESDU 84019 gives the variation of thermal conductivity for 28 compounds from the normal melting point to 0.9 critical temperature at 10 K intervals. They include aromatic hydroxy compounds, aromatic ethers, esters of aromatic acids, together with benzaldehyde and acetophenone. The data were obtained by fitting a polynomial equation to experimental data from a wide range of sources for each compound; the constants of the equation were also faired with molecular structure for compounds that were members of the same chemical series. The normal melting points and critical temperatures are also given, and an equation for predicting the effect of pressure on thermal conductivity for pressures up to 500 atmospheres is suggested. ESDU

**N87-26994** ESDU International Ltd., London (England).
**VAPOUR PRESSURES AND CRITICAL POINTS OF LIQUIDS. INTRODUCTION TO DATA ITEMS ISSUED AFTER SEPTEMBER 1984**
Sep. 1984 8 p
(ESDU-84021; ISBN-0-85679-485-6; ISSN-0141-4062) Avail: ESDU

ESDU 84021 introduces the vapor pressure data in the Sub-series by explaining how a constrained Wagner equation is used to fit available experimental results drawn from the literature. The constraints insure that the vapor pressure curve, derived over the whole liquid range from the freezing point, has certain well established characteristics. The technique used to fit the data is discussed, and the method by which values of critical pressure and temperature are determined is explained. A bibliography and a table of conversion factors for common units of pressure are included. Well established vapor pressure data are required for the design of efficient distillation columns, liquefaction plant, and reactors and for environmental control of the concentration of waste products in the atmosphere. ESDU

**N87-26995#** Purdue Univ., West Lafayette, Ind. School of Mechanical Engineering.
**ASYNCHRONOUS OPTICAL SAMPLING FOR LASER-BASED COMBUSTION DIAGNOSTICS IN HIGH PRESSURE FLAMES Annual Progress Report, 15 Sep. 1985 - 14 Dec. 1986**
Galen B. King, Normand M. Laurendeau, and Fred E. Lytle 15 Dec. 1986 31 p
(Grant AF-AFOSR-0323-84)
(AD-A180618; AFOSR-87-0660TR) Avail: NTIS HC A03/MF A01 CSCL 21B

This report describes progress on the development of a new laser-based combustion diagnostic method for the quantitative measurement of both major and minor species in high pressure flames. The technique, Asynchronous Optical Sampling (ASOPS), is a state-of-the-art improvement in picosecond pump/probe laser spectroscopy. The ASOPS signal has been observed using a solution of rhodamine B in methanol as the sample. The response of the instrument was shown to be proportional to pump power, probe power, and sample absorptance. Different frequency synthesizers and different modes of triggering were used to study their effect on signal stability. Cavity dumpers and frequency doublers have been added to the instrument to prepare for the measurement of the hydroxyl radical in atmosphere laminar flames. GRA

**N87-26996#** California Univ., Irvine. Dept. of Mechanical Engineering.
**SPRAY COMPUTATIONS IN A CENTERBODY COMBUSTOR Report, Oct. 1985 - Oct. 1986**
M. S. Raju and W. A. Sirignano Apr. 1987 13 p
(Grant AF-AFOSR-0016-86)
(AD-A180619; AFOSR-87-0589TR) Avail: NTIS HC A02/MF A01 CSCL 21B

A hybrid Eulerian-Lagrangian method is employed to model the reactive flowfield of a centerbody combustor. The unsteady two-dimensional gas-phase equations are represented in Eulerian coordinates and liquid-phase equations are formulated in Lagrangian coordinates. The gas-phase equations based on the conservation of mass, momentum and energy are supplemented by turbulence and combustion models. The vaporization model takes into account the transient effects associated with the droplet heating and liquid-phase internal circulation. The integration scheme is based on the TEACH algorithm for gas-phase equations, the Runge-Kutta method for liquid-phase equations and linear interpolation between the two coordinate systems. The calculations show that the droplet penetration and recirculation characteristics are strongly influenced by the gas- and liquid-phase interaction in such a way that most of the vaporization process is confined to the wake region of the centerbody and thereby improving the flame stabilization properties of the flowfield. GRA

**N87-26997#** Pennsylvania State Univ., University Park.
**PREMIXED TURBULENT FLAME PROPAGATION Final Report, 30 Sep. 1984 - 30 Sep. 1986**
D. A. Santavicca 12 Feb. 1987 39 p
(Grant AF-AFOSR-0224-84)
(AD-A181013; AFOSR-87-0737TR) Avail: NTIS HC A03/MF A01 CSCL 21B

A pulsed flame flow reactor has been developed for the study of one-dimensional, freely propagating, premixed turbulent flames over a broad range of turbulence Reynolds and Damkohler numbers. Laser Doppler velocimetry is used to characterize the turbulent flow field ahead of the flame in terms of its intensity, length scale and energy spectrum. Two-dimensional imaging is used to characterize the turbulent flame structure. Preliminary results indicate that the method of fractal analysis may be useful for quantifying turbulent flame structure in order to evaluate the effect of turbulence on flame propagation through changes in the flame structure. GRA

**N87-26998#** Princeton Univ., N. J. Dept. of Chemistry.
**GAS-SOLID DYNAMICS AT DISORDERED AND ADSORBATE COVERED SURFACES Final Report, 1 Apr. 1984 - 28 Feb. 1987**
Herschel Rabitz 15 May 1987 11 p
(Grant AF-AFOSR-0106-84)
(AD-A181195; AFOSR-87-0753TR) Avail: NTIS HC A02/MF A01 CSCL 07D

The research under this grant was aimed at several closely related objectives involving studies in chemical dynamics and chemical kinetics. In the case of chemical dynamics, both gas-phase and gas-surface molecular collisions were studied with a special emphasis on the development and application of new techniques. In particular, an average wavefunction procedure was developed especially designed for treating the scattering from complex targets. Applications were made to gas-phase scattering as well as gas-surface scattering in the presence of defects. In the latter case, the focus was on the role that natural defects or adsorbed species have with regard to their influence on the chemical and physical properties of surfaces. GRA

**N87-26999#** California Univ., Davis. Dept. of Mechanical Engineering.
**AERODYNAMIC AND KINETIC PROCESSES IN FLAMES Annual Report, 1 Mar. 1986 - 28 Feb. 1987**
Chung K. Law 1 May 1987 6 p
(Grant AF-AFOSR-0147-85)
(AD-A181267; AFOSR-87-0736TR) Avail: NTIS HC A02/MF A01 CSCL 08B

The flame response in realistic situations is governed by the detailed kinetics of chemical reactions, the diffusion of heat and mass, and the aerodynamic processes of stretching, turbulence, and large-scale flow nonuniformity. During the reporting period good progress was made in the areas of high pressure flame propagation, soot formation in diffusion flames, and analytical modeling of the kinetic and thermal effects on the structure of diffusion flames. GRA

**N87-27000#** California Univ., Irvine. Dept. of Mechanical Engineering.
**VAPORIZATION, IGNITION AND COMBUSTION OF TWO PARALLEL FUEL DROPLET STREAMS Report, Oct. 1985 - Oct. 1986**
R. H. Rangel and W. A. Sirignano Mar. 1987 42 p
(Grant AF-AFOSR-0016-86)
(AD-A181576; AFOSR-87-0592TR) Avail: NTIS HC A03/MF A01 CSCL 21B

An analysis of the combined mechanisms of heat transfer, vaporization, ignition, and combustion of two parallel fuel droplet streams injected in a hot, oxidizing gas flow is presented. The analysis gives a qualitative understanding of the various complex phenomena involved in the vaporization and ignition of one stream of droplets followed by the propagation of the flame to a second stream and the establishment of diffusion flames surrounding each droplet stream. The two-dimensional physical model consists of a constant-property oxidizing gas flowing with a uniform velocity between two insulated planes. The temperature of the gas at the inlet of the channel is specified. The fuel droplet streams are represented as two parallel droplet sheets injected at prescribed locations within the gas flow. Liquid temperature, droplet radius, as well as droplet sheet density and velocity are specified at the inlet. GRA

**N87-27001#** United Technologies Corp., San Jose, Calif. Chemical Systems.
**COUPLING BETWEEN ACOUSTIC VELOCITY OSCILLATIONS AND SOLID PROPELLANT COMBUSTION Final Technical Report, 1 Mar. 1981 - 15 Oct. 1985**
R. S. Brown, A. M. Blackner, P. G. Willoughby, and R. Dunlap 1 Aug. 1986 199 p
(Contract F49620-84-C-0081)
(AD-A181667; AFOSR-87-0612TR) Avail: NTIS HC A09/MF A01 CSCL 21B

The fluid mechanics of the coupling between acoustic waves and the solid propellant combustion have been studied in a cold flow simulation of a solid propellant rocket motor. The axial variation of the oscillatory heat flux shows substantial deviations from the behavior expected from both the linear and nonlinear heuristic models of velocity coupling that are currently used in combustion stability analyses. GRA

**N87-27002#** California Univ., Irvine. Dept. of Mechanical Engineering.
**AN INTEGRATED APPROACH TO SPRAY COMBUSTION MODEL DEVELOPMENT Report, Oct. 1985 - Oct. 1986**
W. A. Sirignano Dec. 1986 33 p
(Grant AF-AFOSR-0016-86)
(AD-A181717; AFOSR-87-0581TR) Avail: NTIS HC A03/MF A01 CSCL 21B

The major elements of an approach to the development of a more powerful spray combustion model is discussed. A model is sought that treats, in a numerically-efficient manner, unsteady, multidimensional, turbulent reacting flows with polydisperse, multicomponent sprays and properly accounts for transient droplet heating and vaporization, liquid-phase mass diffusion, and droplet drag and trajectory. Major advances are reviewed and important issues remaining for resolution are discussed. GRA

**N87-27003#** California Univ., Irvine. Dept. of Mechanical Engineering.
**TRANSIENT SPRAY COMBUSTION COMPUTATIONS Report, Oct. 1985 - Oct. 1986**
William A. Sirignano Sep. 1986 5 p
(Grant AF-AFOSR-0016-86)
(AD-A181726; AFOSR-87-0580TR) Avail: NTIS HC A02/MF A01 CSCL 21B

Many practical combustion devices involve direct injection of liquid fuel into the combustion chamber, e.g., gas turbine engines, diesel engines, rockets and ramjet engines, and furnaces. Typically, the fuel is of sufficiently low volatility that vaporization is an important or controlling factor in the rate of combustion. It is desirable, therefore, to analyze the trajectories, heating, and vaporization of the large number of droplets in a fuel spray and to account for the exchange of mass, momentum, and energy between the liquid and gas phases in order to predict combustor performance, stability, and pollutant emission. A review is made of one-dimensional, unsteady and axisymmetric, unsteady spray combustion calculations. Proper formulation of the governing two-phase equations are discussed. Problems of ignition and flame propagation are examined. Since droplet lifetime is of the same order to magnitude as time for heat transport through the droplet, transient heating of the droplets is considered together with effects of internal droplet circulation due to shear forces on the droplet surface. GRA

**N87-27004#** Geo-Centers, Inc., Newton, Mass.
**LITERATURE REVIEW OF CETANE NUMBER AND ITS CORRELATIONS Progress Report, Jul. 1986 - Mar. 1987**
Seetar G. Pande May 1987 69 p
(Contract N00014-86-C-2288; R08-38)
(AD-A181753; GC-TR-87-1628) Avail: NTIS HC A04/MF A01 CSCL 07D

This review covers the standard method of determining cetane number (engine tests, ASTM D613) and alternative methods, which comprise 1 engine tests method and 33 cetane indices (predictive equations of cetane number). Of the alternative methods, emphasis is given to those which appear or had appeared promising as good predictors of cetane number. The various cetane indices are categorized according to the type of parameters employed viz, physical properties (e.g., the calculated cetane index, ASTM D976, an approved alternative method to ASTM D613), chemical composition/structure, and physico-chemical properties (e.g., spontaneous ignition tests). Of the physical properties, the combination of distillation temperature(s) and density appear to afford good correlations between cetane index and cetane number. Furthermore, these two parameters continue to feature in the replacement equations of D976. For indices based on a single property, aniline point gives the best prediction. GRA

**N87-27005*#** National Aeronautics and Space Administration, Washington, D.C.
**THE CATALYSIS OF HYDRAZINES**
S. Tanatar Aug. 1987 9 p Transl. into ENGLISH from Katalyse des Hydrazins, Zeitschrift fuer Physikalische Chemie, Leipzig, USSR, Akademische, Verlagsgesselschaft, Beest and Portig, v. 41, 1902, p 37-42 Transl. by Kanner (Leo) Associates, Redwood City, Calif. Original document was prepared by Odessa Univ., USSR
(Contract NASw-4005)
(NASA-TT-20053; NAS 1.77:20053) Avail: NTIS HC A02/MF A01 CSCL 07D

Hydrazine sulfate in a hot aqueous solution can be catalyzed in the direction of 3 $N_2H_4$ = 4 $NH_3$ + $N_2$. Free hydrazine in a hot aqueous solution dissociates in the presence of platinum in the following direction: 2 $N_2H_4$ = 2 $NH_3$ + $N_2$ + $H_2$. In the presence of sodium hydroxide, the catalytic dissociation of hydrazine takes a third direction: 3 $N_2H_4$ = 2 $NH_3$ + 2 $N_3$ + 3 $H_2$. Author

**N87-27006*#** National Aeronautics and Space Administration, Washington, D.C.
**SLOW DETONATION, VAPOR EXPLOSION, BUBBLE RESONANCE EXPLOSION: COMMON CHARACTERISTICS**
Carl Otto Leiber Aug. 1987 22 p Transl. into ENGLISH from Langsme Detonation, Dampfexplosion, Blasenresonanzexplosion-Gemeinsamkeiten, West Germany, Chemie Ingenieur Technik, v. 49, no. 12, 1977 p 925-931 Transl. by Kanner (Leo) Associates, Redwood City, Calif.
(Contract NASw-4005)
(NASA-TT-20087; NAS 1.77:20087) Avail: NTIS HC A02/MF A01 CSCL 21B

Explosive phenomena are described in condensed, preferably liquid phases in which the energy is chemically or physically induced. It is shown that there is no principal difference between chemical and physical explosions. Conditions for the existence of explosions are listed; these might also be used for the suppression of explosions. As these conditions are, in part, extremely critical, this type of explosion is currently not utilized technically, but it is of interest with respect to safety questions. Examples of accidents are described. Author

**N87-27007#** Helsinki Univ. of Technology, Espoo (Finland). Dept. of Technical Physics.
**TRANSIENT AND HIGH RESOLUTION MOSSBAUER SPECTROSCOPY Ph.D. Thesis**
Panu Helistoe Nov. 1986 36 p
(ETN-87-90054) Avail: NTIS HC A03/MF A01

Transient methods are shown to yield improvements over existing Mossbauer spectroscopic techniques. The results are interpreted in terms of a semiclassical model, which very well predicts the observed effects. Limits of the model's validity are discussed. Effects observed in scattering geometry are analyzed. Applications in which transient methods are especially useful are presented. The isotope Zn 67 is found to be very suitable for transient experiments, but experiments with Fe 57 are shown to be feasible. Transient methods are compared with other measurement techniques in precise measurements of small energy shifts. The shift between the resonance energies of a Ga 67:ZnO source and a Zn67O absorber is measured. ESA

# 26 METALLIC MATERIALS

Includes physical, chemical, and mechanical properties of metals, e.g., corrosion; and metallurgy.

**N87-27008*#** Clarkson Univ., Potsdam, N.Y.
**BRIDGMAN CRYSTAL GROWTH**
Frederick M. Carlson Feb. 1987 12 p

(Grant NAG1-397)
(NASA-CR-180958; NAS 1.26:180958) Avail: NTIS HC A02/MF A01 CSCL 20B

The primary focus was on completing a simulation of thermosolutal convection. The configuration employed was based on some MIT experiments using a Germanium-Silicon charge in a quartz ampoule with an aspect ratio of 8 and a rather large adiabatic zone. Two thermally stable cases were investigated: solutally unstable and solutally stable. Both use the same equilibrium phase diagram and thermophysical properties except the sign of the solutal coefficient of volume expansion is reversed. The results are discussed. B.G.

**N87-27009#** Rockwell International Corp., Golden, Colo.
**PROCEEDINGS OF THE CONFERENCE ON PROGRESS IN RESOLVING UNDESIRABLE TRACE ELEMENT EFFECTS ON THE WELDABILITY OF STEELS**
C. R. Heiple, ed. 28 Nov. 1986 57 p Conference held in Charlotte, N.C., 21 Nov. 1985
(Contract DE-AC04-76DP-03533)
(DE87-008544; RFP-4048; CONF-8511282) Avail: NTIS HC A04/MF A01

Residual elements were known for many years to affect welding behavior, as illustrated by hot cracking of steel due to sulfur and phosphorus. It has become clear recently that trace elements can also have a profound influence on the behavior of the weld pool itself. Recent work has demonstrated that a change of 50 ppm in the level of certain trace elements can change the aspect ratio of Gas Tungsten Arc (GTA) and conduction mode laser or electron beam welds by more than a factor of two. These changes in weld shapes with base metal composition are particularly troublesome in high precision, automatic welding applications, such as in GTA welding of stainless steel components for the nuclear, chemical, and aerospace industries. There was substantial progress in the past several years in understanding the effect of trace element on GTA weld shape. The effects of trace elements are discussed relative to GTA weld pool shapes, weld penetration, and welding characteristics. B.G.

**N87-27010#** Commissariat aux Energies Nouvelles, Algiers (Algeria). Centre d'Etudes Nucleaires et Solaires.
**LIQUID-SOLID PHASE EQUILIBRA OF THE (Ni-G-Co-W)-Al-Ta MULTICONSTITUENT SYSTEM, TYPE SUPER ALLOYS M.S. Thesis**
S. Bouterfaia Jan. 1986 62 p In FRENCH
(DE87-701989; INIS-mf-10812) Avail: NTIS (US Sales Only) HC A04/MF A01

The progressive improvement over the past years in mechanical properties and increasing work temperature was achieved to nickel-base superalloys. The importance of its use (Aerospace, nuclear industry) impose main characteristics: high stress and creep resistance; hot corrosion and oxidation resistance at high temperature for long times. These properties are obtained by increasing the amount of hardening phase together with processing innovations as single crystal casting. Moreover we intend to study the modifications arising from additional elements. The ultimate aim is to calculate complex superalloys phase diagrams. A number of master alloys were melted with intermediate compositions using high purity charge material (99.95%). Using different techniques (DTA, TATD) more accurate observations were made in electron microprobe and electron diffraction. The phases were identified within the system, the liquidus diagram is traced. The liquidus surface of primary solid solution was represented by a second-order polynomial function which allows us to calculate point temperature surface and to trace the isotherm lines. The solidification sequences with the amount of microanalysis shows that the optimization of additional elemental compositions is important in order to avoid the fragile phases in superalloys. We notice that, for obtaining an alloy susceptible to give a monocrystalline solidification, the choice of composition is more important. DOE

**N87-27011#** Los Alamos National Lab., N. Mex.
**THE RATE DEPENDENCE OF STRUCTURE EVOLUTION IN COPPER AND ITS INFLUENCE ON THE STRESS-STRAIN BEHAVIOR AT VERY HIGH STRAIN RATES**
Paul S. Follansbee 1987 14 p Presented at the IMPACT '87 International Conference on Impact Loading and Dynamic Behavior of Materials, Bremen, West Germany, 18-21 May 1987
(Contract W-7405-eng-36)
(DE87-010114; LA-UR-87-1585; CONF-8705109-6) Avail: NTIS HC A02/MF A01

A model for the deformation of copper over a wide range of strain rates has been modified to account for the contribution of dislocation drag at high strain rates. The main effect of adding this mechanism is found in the near yield region at strain rates exceeding 10 to the 3d power/s. However, even at strain rates as high as 10 to the 6th power/s the rate controlling deformation mechanism at strains greater than roughly epsilon=0.1 is thermal activation. It is postulated that the high stresses predicted at yield when the strain rates are raised above 10 to the 3d power/s may lead to the rapid dislocation accumulation rates that have been found experimentally and which lead to the increased strain-rate sensitivity reported for copper and other metals at these strain rates. DOE

**N87-27012#** Pacific Northwest Labs., Richland, Wash.
**MICROSTRUCTURAL EFFECTS ON MICRODEFORMATION AND PRIMARY-SIDE STRESS CORROSION CRACKING OF ALLOY 600 TUBING Final Report**
S. M. Bruemmer, L. A. Charlot, and C. H. Henager, Jr. May 1987 74 p Prepared for EPRI, Palo Alto, Calif.
(Contract DE-AC06-76RL-01830; EPRI Proj. RP2163-4)
(DE87-010293; EPRI-NP-5192) Avail: NTIS HC A04/MF A01

Microdeformation characteristics in Alloy 600 tubing have been examined after various tensile deformations. Microstructure developed during processing was found to control subsequent microdeformation behavior. Grain boundary carbides were the most effective source of dislocations, activating at lower macro-strains and continuing to operate at higher macro-strains than other sources. Ledges within grain boundaries, twin boundaries and matrix carbides also acted as dislocation sources. Most dislocation activity at low strains was confined to planar arrays. A conceptual model is presented to account for the effects of interfacial and matrix microstructure on microdeformation and primary-side SCC of Alloy 600 tubing. Microstructure is linked to IGSCC resistance through its influence on microdeformation behavior and the resultant crack-tip stress state. Dislocation source activity at grain interfaces is proposed to be a critical aspect controlling IGSCC susceptibility. Effective sources such as grain boundary carbides promote crack blunting, decrease the crack-tip stress state and increase resistance to cracking. DOE

**N87-27013#** Dartmouth Coll., Hanover, N.H. School of Engineering.
**THE ROLE OF GRAIN BOUNDARIES ON THE STRENGTH, DUCTILITY AND TOUGHNESS OF LI SUB 2 INTERMETALLIC COMPOUNDS**
Erland M. Schulson 16 Mar. 1987 7 p
(Contract DE-FG02-86ER-45260)
(DE87-010821; DOE/ER-45260/1) Avail: NTIS HC A02/MF A01

The objective of this program is to understand the mechanisms underlying the effects of grain boundaries on the flow and fracture of Ni3Al and Ni3Si. This report summarizes progress during the first year; i.e., from July 15, 1986 to March 15, 1987. DOE

**N87-27014#** Ames Lab., Iowa.
**SOLIDIFICATION DYNAMICS IN BINARY ALLOY SYSTEMS Ph.D. Thesis - Iowa State Univ.**
Mark Alan Eshelman Jun. 1987 282 p
(Contract W-7405-eng-82)
(DE87-010926; IS-T-1284) Avail: NTIS HC A13/MF A01

Quantitative directional solidification experiments were carried out in transparent metal analog systems to examine linear and

nonlinear theories of planar interface instability, to track the pattern formation process, to examine steady-state and dynamical processes in the cellular growth region, and to examine the effects of anisotropy of interface properties on growth morphologies. Studies of pattern formation show that this process is not entirely chaotic, but rather, a discrete set of transition wavenumbers exist during the pattern formation process. Studies in the cellular growth region show that the steady-state cellular spacing decreases, increases sharply, and again decreases as the velocity is increased from the point of planar interface instability to the maximum cell growth velocity. Dynamic experiments in the cellular growth region show that adjustment of the cell spacing requires drastic growth morphology changes when the growth conditions are changed slowly in systems where anisotropy of interface properties is present. Studies of the effects of anisotropy interface properties cause cell translation parallel to an advancing solid-liquid interface when the (001) crystallographic direction is not in line with the heat flow direction. DOE

**N87-27015#** Ames Lab., Iowa.
**EFFECTS OF OXYGEN AND HYDROGEN ON TENSILE AND INTERNAL FRICTION PROPERTIES OF NIOBIUM-VANADIUM ALLOYS Ph.D. Thesis - Iowa State Univ.**
Hendra Indrawirawan Jun. 1987 139 p
(Contract W-7405-eng-82)
(DE87-010933; IS-T-1243) Avail: NTIS HC A07/MF A01

The effect of additions of up to 10 at% vanadium on the oxygen Snoek peak in niobium was investigated by an internal friction technique. Vanadium-oxygen interaction peaks were identified at 500 and 650 K. For the Nb-0.24 at% V and the Nb-0.42 at% V alloys, at an oxygen/vanadium ratio greater than one, the 400 K unperturbed oxygen Snoek peak in niobium appears, thus providing strong evidence for oxygen trapping in these alloys. The 500 K peak is interpreted as a stress induced reorientation of oxygen associated with a single vanadium atom in a type n = 1 cell, whereas the 650 K peak is due to oxygen associated with two or more vanadium atoms in type n = 2 and n = 3 cells. The observed results are discussed in terms of the elastic and chemical interaction models for substitutional-interstitial solute interactions in a bcc lattice. Internal friction results do not provide evidence of an oxygen-hydrogen interaction. Hydrogen has no observable effect on the oxygen Snoek peak in unalloyed niobium and oxygen has no effect on the peak temperature or activation enthalpy for hydrogen relaxation in the Nb-10 at% V alloy. The effects of oxygen and hydrogen on the tensile properties of the Nb-10 at% V alloy were also studied. The addition of oxygen increases both the thermal and athermal stress components, although the effect is more pronounced on the thermal than on the athermal stress component. The 0.2% tensile yield stress is proportional to concentration as it is predicted for a concentrated solid solution. For the Nb-10 at. % V alloy containing hydrogen, alloy softening is observed at approx 125 K regardless of the presence of oxygen. This behavior is explained by the stress-induced ordering of hydrogen atoms in this temperature range. The effect of hydrogen on the strengthening and ductility of this alloy is much more pronounced in the presence of oxygen than in the low oxygen alloy. DOE

**N87-27016#** Army Lab. Command, Watertown, Mass. Material Technology Lab.
**MICROSTRUCTURAL CHARACTERIZATION OF A COBALT-FREE MARAGING STEEL, VASCO MAX T-250 Final Report**
Kerry N. Siebein Feb. 1987 25 p
(AD-A180927; MTL-TR-87-12) Avail: NTIS HC A02/MF A01 CSCL 11F

A cobalt-free maraging steel, Vasco Max T-250, is being used as a replacement for the conventional, 18% Ni 300 grade maraging steel used by the Army. The thrust of this program was to characterize the microstructure of annealed and aged specimens using optical and electron microscopy and X-ray diffraction. The structure of the annealed sample is a heavily dislocated lath martensite. The aged sample are a lath martensite that contains very fine Ni3Ti second phase particles. The precipitates are coherent with the matrix and form in a Widmanstatten pattern. The Ni3Ti precipitates are a very effective strengthening phase of the Vasco Mas T-250 and the aging temperature that appears to optimize the strengthening precipitates is 950 F. GRA

**N87-27017#** SRI International Corp., Menlo Park, Calif.
**EVALUATION OF A DIFFUSION/TRAPPING MODEL FOR HYDROGEN INGRESS IN HIGH-STRENGTH ALLOYS Annual Technical Report, 15 Mar. 1986 - 15 Mar. 1987**
Bruce G. Pound 14 May 1987 31 p
(Contract N00014-86-C-0233)
(AD-A181206) Avail: NTIS HC A03/MF A01 CSCL 11F

This report covers work performed during the first year of a program to apply a diffusion/trapping model for hydrogen ingress in three high-strength alloys, AISI 4340 steel, Monel K500, and MP35N. The model is coupled to the use of a potentiostatic double-pulse technique, and current transient data were obtained for the alloys in 1 M HAc/1 M NaAc (Ac = acetate) with 15 ppm AS2O3. In all cases, the anodic charge can be analyzed as a function of charging time in terms of an interfacial control model in which the rate of H ingress into the metal is determined by the flux across the metal surface. The 4340 steel was tested at yield strengths of approximately 175 and 250 ksi. The rate constant for irreversible trapping, k, was evaluated from the measured or apparent rate constant, ka, by estimating the effect of reversible traps from diffusivity data and was found to be 4/s for both 4340 specimens. GRA

**N87-27018#** Massachusetts Inst. of Tech., Cambridge. Center for Materials Science and Engineering.
**SYNTHETIC METALS FROM INTERCALATED GRAPHITE Semiannual Report no. 5, 1 Oct. 1986 - 31 Mar. 1987**
M. S. Dresselhaus and G. Dresselhaus 11 May 1987 12 p
(Contract F49620-83-C-0011)
(AD-A181245; AFOSR-87-0745TR) Avail: NTIS HC A02/MF A01 CSCL 11D

During the six month period October 1, 1986 to March 31, 1987, efforts on the Program Synthetic Metals from Intercalated Graphite were largely focused on studies of magnetic and superconducting graphite intercalation compounds. A summary of the accomplishments of the research program is presented. GRA

**N87-27019#** Naval Ship Research and Development Center, Annapolis, Md. Ship Materials Engineering Dept.
**MICROMECHANISMS OF FRACTURE AND CRACK ARREST IN TWO HIGH STRENGTH STEELS Research and Development Report, Sep. 1984 - Oct. 1985**
J. P. Gudas Feb. 1987 322 p
(AD-A181324; DTNSRDC/SME-87-20) Avail: NTIS HC A14/MF A01 CSCL 11F

An investigation of fracture properties of a quenched and tempered martensitic steel and copper precipitation on strengthened low carbon ferritic steel possessing similar yield strengths was conducted. The objective included evaluation of fracture toughness, and explanation of metallurgical mechanisms causing changes in relative fracture performance. A crack arrest toughness test procedure was developed to obtain full plate thickness, lower bound measurements of dynamic fracture toughness at various test temperatures. Micromechanisms of fracture processes were described using metallurgical analysis techniques. GRA

**N87-27020#** Drexel Univ., Philadelphia, Pa. Dept. of Materials Engineering.
**A FUNDAMENTAL STUDY OF P/M (POWDER METALLURGY) PROCESSED ELEVATED TEMPERATURE ALUMINUM ALLOYS Annual Final Report, 1 Oct. 1985 - 28 Feb. 1986**
A. Lawley and M. J. Koczak Apr. 1987 28 p
(Grant AF-AFOSR-0010-82)
(AD-A181380; AFOSR-87-0733TR) Avail: NTIS HC A03/MF A01 CSCL 11F

Al-Fe-Ni powder containing 0.19 volume fraction of FeNiAl9 dispersoid (approx. 0.18 micrometers) was mechanically alloyed (MA) and hot extruded. There is a significant enhancement in creep response compared to the same alloy without MA and microstructural stability is superior. Improvements in creep strength and microstructural stability are attributed to the presence of fine-scale (approx. 30 nm) oxides/carbides introduced during MA distributed uniformly throughout the matrix, at matrix-intermetallic interfaces, and on subgrain boundaries. The fine-scale dispersion inhibits coarsening and appears to interact with the diffusing Fe and Ni atoms. GRA

**N87-27021#** Pratt and Whitney Aircraft, West Palm Beach, Fla. Government Products Div.
**FUNDAMENTAL UNDERSTANDING OF THE INTRINSIC DUCTILITY IN NICKEL-BASE L12 TYPE ALLOYS Annual Report, 15 Feb. 1986 - 14 Feb. 1987**
C. C. Law, D. M. Shah, and J. Lin 12 May 1987 53 p
(Contract F49620-86-C-0033)
(AD-A181385; PW/GPD-FR-19801; AFOSR-87-0771TR) Avail: NTIS HC A04/MF A01 CSCL 11F

To study the effects of alloying on ductility of Ni3Al alloys, three series of alloys were formulated and produced as single crystals. The alloying additions selected include tantalum, tin and titanium which tend to destabilize the L12 lattice toward different derivative structures by changing the relative magnitudes of the planar fault energies. These alloying effects are being studied in terms of the structural configuration of dislocations produced, deformation behavior and the resulting ductility of the alloys. A major effort in the first year program was to grow single crystals of the selected alloys and some technical difficulties were encountered. Single crystals of all the selected alloys with the exception of a tin-containing alloy have now been successfully grown. Tensile testing has been completed for a tantalum and a titanium-containing alloy. Relative to the binary alloy, the alloying additions were found to significantly increase the critical resolved shear strength CRSS for octahedral slip system without substantially affecting the CRSS for the cube slip system. GRA

**N87-27022#** Virginia Univ., Charlottesville. Dept. of Materials Science.
**THE USE OF NOVEL PROCESSING PROCEDURES FOR IMPROVING OVERALL FATIGUE RESISTANCE OF HIGH STRENGTH ALUMINUM ALLOYS Final Report, 1 Jan. 1984 - 31 Dec. 1986**
Edgar A. Starke, Jr. and J. A. Wert May 1987 72 p
(Grant AF-AFOSR-0061-83)
(AD-A181421; UVA/525644/MS87/102; AFOSR-87-0730TR)
Avail: NTIS HC A04/MF A01 CSCL 11F

In Part 1 of this investigation, ductile fracture of 2134 aluminum alloys stabilized by Zirconium has been studied as a function of Mn rich particle content in the under and overaged conditions. As expected in the highest Mn containing alloy voids/sq mm, void growth rate, and void volume fraction were the highest whereas in alloys with 0% and 0.31% Mn these parameters were somewhat similar and lower. Part 2 of this investigation has examined interangular fracture during heat treatment and deformation of an Al-Li-Cu alloy and an Al-Li-Cu-Mg alloy. When the Al-Li-Cu-Mg alloy used in this study is solution treated by rapid heating to 550 C, nonequilibrium eutectic melting of a soluble phase occurs. GRA

**N87-27023#** Naval Postgraduate School, Monterey, Calif.
**AN INVESTIGATION OF THE HOT CORROSION PROTECTIVITY BEHAVIOR OF PLATINUM MODIFIED ALUMINIDE COATINGS ON NICKEL-BASED SUPERALLOYS M.S. Thesis**
Rudolph E. Malush Mar. 1987 101 p
(AD-A181795) Avail: NTIS HC A06/MF A01 CSCL 11C

The adverse operating environments encountered by marine gas turbine components has necessitated the development of various protective coating systems. Diffusion aluminide coatings have been used successfully for many years to enhance the hot corrosion resistance of turbine blades and vanes. Recently, it has been found that by modifying these standard aluminide coatings with a thin platinum underlay, significant improvements in high temperature corrosion resistance can be achieved. Using a laboratory furnace specifically modified to reproduce hot corrosion attack morphologies, the effects of selected platinum-aluminide coating deposition variables were investigated on two nickel-base superalloy substrates. GRA

**N87-27024*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**PERMEATION OF OXYGEN THROUGH HIGH PURITY, LARGE GRAIN SILVER**
R. A. Outlaw, W. K. Peregoy, and Gar B. Hoflund (Florida Univ., Gainesville.) Sep. 1987 19 p
(NASA-TP-2755; L-16305; NAS 1.60:2755) Avail: NTIS HC A02/MF A01 CSCL 11F

The permeation of high purity, large grain Ag membranes by oxygen has been studied over the temperature range 400 to 800 C. The permeability was found to be quite linear and repeatable, but the magnitude was 3.2 times smaller than that determined by past research. Since previous investigators studied substantially less pure Ag and conducted experiments within much poorer vacuum environments (which indicates that their grain boundary density was much greater), the data presented here suggest oxygen transport through the membrane is primarily by grain boundary diffusion. The diffusivity measurements were found to exhibit two distinct linear regions, one above and one below a critical temperature of 630 C. The high-temperature data have an activation energy (11.1 kcal/mole) similar to that reported by others, but the low-temperature data have a higher activation energy (15.3 kcal/mole), which can be explained by impurity trapping in the grain boundaries. Vacuum desorption of the oxygen-saturated Ag was found to occur at a threshold of 630 C, which is consistent with the onset of increased mobility within the grain boundaries. Author

**N87-27025#** Oak Ridge National Lab., Tenn.
**WHITE PAPER ON AB INITIO THEORY OF ALLOY PHASE STABILITY**
G. M. Stocks Mar. 1987 3 p Presented at the Workshop on Advanced Computation and Simulation of Complex Materials Phenomena, La Jolla, Calif., 24 Mar. 1987
(Contract DE-AC05-84OR-21400)
(DE87-008947; CONF-8703123-1) Avail: NTIS HC A02/MF A01

Density functional theory (DFT) provides an excellent bases for describing the ground state properties of metallic alloys. The local density approximation (LDA) to DFT has been used to calculate total energies, equilibrium lattice spacings, bulk moduli, heats of formation of ordered alloys, and heats of transformation all with good results. Recent work has extended LDA and DFT to random (substitutional) metallic alloys where the electronic structure is calculated using the ab initio Korringa-Kohn-Restoker coherent-potential approximation (KKR-CPA). It is appropriate to consider the possibility of obtaining an ab initio theory of alloy phase stability based on DFT. During the next few years it is to be expected that ab initio methods will be applied to many problems in the area of phase stability. This paper presents some applications that are already under way or that can readily be seen given adequate manpower and computational support. DOE

**N87-27026#** Oak Ridge National Lab., Tenn.
**DEVELOPMENT OF Fe3Al-BASED ALUMINIDES**
C. G. McKamey, C. T. Liu, S. A. David, J. A. Horton, and J. V. Cathcart 1987 14 p Presented at the Fossil Energy Materials Program Conference, Oak Ridge, Tenn., 19 May 1987
(Contract DE-AC05-84OR-21400)
(DE87-010019; CONF-8705103-4) Avail: NTIS HC A02/MF A01

Iron aluminides based on Fe3Al possess many attractive properties for structural use. However, limited ductility at ambient temperatures and a sharp drop in strength above 600 C restrict their use as structural materials. The goal of the present study is

to develop Fe3Al-based aluminides with optimum combinations of strength, ductility, and corrosion resistance for use as hot components in advanced fossil energy conversion systems. From a study of the properties of alloys of 24 to 30 at% Al, it has been determined that the most promising alloy for further development is Fe-28 at% Al. A discussion of the effect of aluminum concentration on mechanical properties is included in this paper. Initially, 0.5 wt% TiB2 was added for grain refinement. It has since been determined that these precipitates are deleterious to the weldability, and for future alloy development they will not be added. Alloy additions have been shown to improve both the high-temperature strength and room-temperature ductility. Results of weldability and tensile and creep tests, as well as the present status of oxidation and aqueous corrosion tests, are reported. DOE

**N87-27027*#** Johns Hopkins Univ., Baltimore, Md. Dept. of Material Science and Engineering.

**INVESTIGATION OF THE MICROSTRUCTURE OF RAPIDLY SOLIDIFIED ALLOYS**

D. Shechtman and E. Horowitz Jun. 1987 36 p
(Grant NAG1-399)
(NASA-CR-180669; NAS 1.26:180669) Avail: NTIS HC A03/MF A01 CSCL 11F

A number of selected aluminum alloys were investigated using optical microscopy, transmission electron microscopy, and X-ray diffraction to gain a better understanding of the relationship between various processing treatments and the microstructure of the alloys. The samples were quite similar in elemental composition (Cu, Mg, Si, Fe, Ni, Mn, Zr, Zn, and Cr) but two of the alloys, samples 514041 and 514042, differed in Zr content and contained 0.12 and 0.60 wt %, respectively. Three annealing temperatures were used, 300, 400, and 508 C. Information on the nature of the microstructure was shown in a series of 39 photomicrographs with accompanying discussion and explanation. The changes in the microstructure as a result of heat treatment are reported. B.G.

**N87-27028#** Lawrence Livermore National Lab., Calif.

**PHASE STABILITY BY THE ARTIFICIAL CONCENTRATION WAVE METHOD**

A. F. Jankowski and T. Tsakalakos 22 May 1987 19 p Presented at the NATO Advanced Study Institute on Alloy Phase Stability, Crete, Greece, 14 Jun. 1987 Prepared in cooperation with Rutgers - The State Univ., Piscataway, N.J.
(Contract W-7405-eng-48)
(DE87-010877; UCRL-96671; CONF-8706103-2) Avail: NTIS HC A02/MF A01

Phase stability can be examined by means of concentration waves. X-ray diffraction techniques are utilized to study the growth and decay of the concentration waves, from which critical temperatures can be determined. Artificial composition modulated foils (of short period) examined include Cu/Ni, Cu/NiFe, Cu/NiCr, and Cu/NiSn. The theory of static concentration waves can be employed to predict phase structure, stability, critical temperature, and kinetics. DOE

**N87-27029*#** Pratt and Whitney Aircraft, East Hartford, Conn. Engineering Div.

**MATERIALS FOR ADVANCED TURBINE ENGINES (MATE). PROJECT 4: EROSION RESISTANT COMPRESSOR AIRFOIL COATING**

J. M. Rashid, M. Freling, and L. A. Friedrich May 1987 88 p
(Contract NAS3-20072)
(NASA-CR-179622; NAS 1.26:179622; PWA-5574-206) Avail: NTIS HC A05/MF A01 CSCL 11F

The ability of coatings to provide at least a 2X improvement in particulate erosion resistance for steel, nickel and titanium compressor airfoils was identified and demonstrated. Coating materials evaluated included plasma sprayed cobalt tungsten carbide, nickel carbide and diffusion applied chromium plus boron. Several processing parameters for plasma spray processing and diffusion coating were evaluated to identify coating systems having the most potential for providing airfoil erosion resistance. Based on laboratory results and analytical evaluations, selected coating systems were applied to gas turbine blades and evaluated for surface finish, burner rig erosion resistance and effect on high cycle fatigue strength. Based on these tests, the following coatings were recommended for engine testing: Gator-Gard plasma spray 88WC-12Co on titanium alloy airfoils, plasma spray 83WC-17Co on steel and nickel alloy airfoils, and Cr+B on nickel alloy airfoils. Author

**N87-27030*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.

**THE EFFECT OF TRICRESYL-PHOSPHATE (TCP) AS AN ADDITIVE ON WEAR OF IRON (Fe)**

Hiren M. Ghose, John Ferrante, and Frank C. Honecy Aug. 1987 17 p
(NASA-TM-100103; E-2883; NAS 1.15:100103) Avail: NTIS HC A02/MF A01 CSCL 11F

The effect of tricresyl phosphate (TCP) as an antiwear additive in lubricant trimethyol propane triheptanoate (TMPTH) was investigated. The objective was to examine step loading wear by use of surface analysis, wetting, and chemical bonding changes in the lubricant. The investigation consisted of steploading wear studies by a pin or disk tribometer, the effects on wear related to wetting by contact angle and surface tension measurements of various liquid systems, the chemical bonding changes between lubricant and TCP chromatographic analysis, and by determining the reaction between the TCP and metal surfaces through wear scar analysis by Auger emission spectroscopy (AES). The steploading curve for the base fluid alone shows rapid increase of wear rate with load. The steploading curve for the base fluid in presence of 4.25 percent by volume TCP under dry air purge has shown a great reduction of wear rate with all loads studied. It has also been found that the addition of 4.25 percent by volume TCP plus 0.33 percent by volume water to the base lubricant under N2 purge also greatly reduces the wear rate with all loads studied. AES surface analysis reveals a phosphate type wear resistant film, which greatly increases load-bearing capacity, formed on the iron disk. Preliminary chromatographic studies suggest that this film forms either because of ester oxidation or TCP degradation. Wetting studies show direct correlation between the spreading coefficient and the wear rate. Author

**N87-27031#** Technical Research Centre of Finland, Espoo. Metals Lab.

**METALLURGICAL FACTORS AFFECTING CLEAVAGE FRACTURE IN STEEL**

Kim Wallin Jan. 1987 21 p Sponsored by the Finnish Ministry of Trade and Industry, and the Finnish Academy
(VTT-RR-460; ISBN-951-38-2784-4; ISSN-0358-5077; ETN-87-90056) Copyright Avail: NTIS HC A02/MF A01

The relative effect of metallurgical variables on cleavage fracture initiation was evaluated by applying a statistical cleavage fracture model. It is found that the carbide size, yield stress, and strain hardening are dominant parameters controlling cleavage fracture initiation. ESA

**N87-27032#** Admiralty Marine Technology Establishment, Holton Heath (England). Materials and Life Sciences Dept.

**MODELING OF BIMETALLIC CORROSION IN SEAWATER SYSTEMS**

D. J. Astley and J. C. Rowlands Oct. 1984 15 p
(AMTE(M)-TM-84227; BR100326; ETN-87-90094) Avail: NTIS HC A02/MF A01

Galvanic current measurements using a zero resistance ammeter on metals coupled at different anode to cathode area ratios formed a basis for the calculation of bimetallic corrosion effects. In practice systems often have complex geometries, so that the effective area ratio differs from the physical area ratio owing to resistive losses in the electrolyte. Real systems frequently consist of more than two different metals so that data relating to simple bimetal combinations may be inadequate for the estimation of corrosion rates. Mathematical models to calculate the magnitude and distribution of corrosion rates in such systems were developed.

The application of such modeling is illustrated for bimetallic corrosion in a mixed metal heat exchanger, and for the extent of cathodic protection down a copper alloy pipe system. ESA

**N87-27033#** University Coll. of Swansea (Wales). Dept. of Metallurgy and Materials Technology.
**SIMULTANEOUS SPRAY PEENING OF ALUMINUM ALLOYS Final Report**
A. D. Roche and A. R. E. Singer 9 Oct. 1986 54 p
(Contract MOD-A91a/1162)
(BR100769; ETN-87-90102) Avail: NTIS HC A04/MF A01

The feasibility of spray depositing with peening aluminum alloy compositions ordinarily prepared by powder metallurgy techniques was investigated. The process comprises spray deposition of metals with simultaneous shot peening. The deposits are hot worked and densified during the process, improving their properties compared with more conventional spray deposits. Advantages include rapid solidification on a substrate by splat cooling and a much shorter and more economical route to the final product. The PM alloys investigated include the high-strength 7091 alloy and the thermally stable alloys Al-Fe-Ce and Al-Cr-Zr-Mn. The mechanical properties of sprayformed material are as good as or better than conventionally produced material. In contrast to other rapid solidification techniques low oxygen pickups in the sprayforming process are noted. ESA

# 27 NONMETALLIC MATERIALS

Includes physical, chemical, and mechanical properties of plastics, elastomers, lubricants, polymers, textiles, adhesives, and ceramic materials.

For composite materials see *24 Composite Materials*.

**N87-27034*#** College of William and Mary, Williamsburg, Va. Dept. of Chemistry.
**SPACE ENVIRONMENTAL EFFECTS ON POLYMERIC MATERIALS Semiannual Status Report, 1 Mar. 1986 - 1 Jan. 1987**
Richard L. Kiefer and Robert A. Orwoll 4 Feb. 1987 15 p
(Grant NAG1-678)
(NASA-CR-180336; NAS 1.26:180336) Avail: NTIS HC A02/MF A01 CSCL 11B

A study is presented of the effect of radiation on polymers. It helps to estimate the impact of the space environment on composite structures. Two commercially available polymer films were used; a polyetherimide, and a polysulfone. Both films were irradiated in vacuum with 85 KeV electron. Properties of the films before and after irradiation were monitored by tensile elongation measurements, ultraviolet/visible spectroscopy, glass transition temperature measurements, gel permeation chromatography, and infrared spectroscopy. The results of these characterizations are presented and briefly discussed. Author

**N87-27035*#** Michigan Univ., Ann Arbor. Dept. of Mechanical Engineering and Applied Mechanics.
**COMPOSITE THEORY APPLIED TO ELASTOMERS**
S. K. Clark Sep. 1986 36 p
(Grant NsG-1607)
(NASA-CR-180322; NAS 1.26:180322) Avail: NTIS HC A03/MF A01 CSCL 11B

Reinforced elastomers form the basis for most of the structural or load carrying applications of rubber products. Computer based structural analysis in the form of finite element codes was highly successful in refining structural design in both isotropic materials and rigid composites. This has lead the rubber industry to attempt to make use of such techniques in the design of structural cord-rubber composites. While such efforts appear promising, they were not easy to achieve for several reasons. Among these is a distinct lack of a clearly defined set of material property descriptors suitable for computer analysis. There are substantial differences between conventional steel, aluminum, or even rigid composites such as graphite-epoxy, and textile-cord reinforced rubber. These differences which are both conceptual and practical are discussed. B.G.

**N87-27036*#** Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Chemistry.
**TOUGHENING OF BIS MALEIMIDE RESINS: SYNTHESIS AND CHARACTERIZATION OF MALEIMIDE TERMINATED POLY(ARYLENE ETHER) OLIGOMERS AND POLYMERS Final Report, 30 Jul. 1985 - 1 Jul. 1986**
J. E. McGrath, G. D. Lyle, M. J. Jurek, D. Mohanty, and J. C. Hedrick 24 Nov. 1986 25 p
(Contract NCC1-63)
(NASA-CR-180320; NAS 1.26:180320) Avail: NTIS HC A02/MF A01 CSCL 11B

Amine functional poly(arylene ether) sulfones were previously reported. Herein, the chemistry was extended to amorphous poly(arylene ether) ketones because of their higher fracture toughness values, relative to the polysulfones. It was demonstrated that the amino functional oligomers undergo a self-crosslinking reaction at temperatures above about 220 C. This produces an insoluble, but ductile network that has excellent resistance. A ketamine structure hypothesis was proposed and verified using solid state magic angle NMR. In most cases, the water generated upon ketamine formation is too low to produce porosity and solid networks are obtained. The stability of the ketamine networks towards hydrolysis is excellent. The chemistry was further demonstrated to be able to crosslink preformed nonfunctional poly(arylene ether) ketones if a difunctional amine was utilized. This concept has the possibility of greatly improving the creep resistance of thermoplastics. Also, a new technique was developed for converting the amine functional oligomers cleanly into maleimide structures. This method involves reacting maleic anhydride with monomeric aminophenols in the presence of solvent mixtures. Author

**N87-27037*#** Old Dominion Univ., Norfolk, Va. Dept. of Mechanical Engineering and Mechanics.
**STUDIES ON CHEMOVISCOSITY MODELING FOR THERMOSETTING RESINS Progress Report, period ending 31 Jan. 1987**
J. M. Bai, T. H. Hou, and S. N. Tiwari May 1987 96 p
(Grant NAG1-569)
(NASA-CR-180978; NAS 1.26:180978) Avail: NTIS HC A05/MF A01 CSCL 11B

A new analytical model for simulating chemoviscosity of thermosetting resins has been formulated. The model is developed by modifying the well-established Williams-Landel-Ferry (WLF) theory in polymer rheology for thermoplastic materials. By introducing a relationship between the glass transition temperature Tg(t) and the degree of cure alpha(t) of the resin system under cure, the WLF theory can be modified to account for the factor of reaction time. Temperature dependent functions of the modified WLF theory constants C sub 1 (t) and C sub 2 (t) were determined from the isothermal cure data. Theoretical predictions of the model for the resin under dynamic heating cure cycles were shown to compare favorably with the experimental data. This work represents progress toward establishing a chemoviscosity model which is capable of not only describing viscosity profiles accurately under various cure cycles, but also correlating viscosity data to the changes of physical properties associated with the structural transformation of the thermosetting resin systems during cure. Author

**N87-27038#** Corning Glass Works, N.Y. Research and Development Div.
**PHYSICAL AND OPTICAL PROPERTIES OF CHROMIUM-DOPED GLASS-CERAMICS**
G. H. Beall, D. R. Cole, D. W. Hall, H. J. Holland, J. W. H. Schreurs, M. Edwards, R. Gilles, and A. Lempicki (Boston Univ., Mass.) 1987 144 p
(Contract DE-FG02-84ER-45103)
(DE87-010584; DOE/ER-45103/T1) Avail: NTIS HC A07/MF A01

The physical and optical properties of glass-ceramics containing transition metal ions are reported. Work centers on the mullite glass-ceramic family with chromium as the active center, although other hosts and dopants are considered. Crystallite structure, absorption spectra, and luminescent properties are examined for a wide range of precursor glass compositions. Detailed measurements of crystallite morphology and structure, absolute quantum efficiency, and scattering coefficients are made for two promising compositions as a function of heat treatment. For a specific heat treatment, one composition has a wavelength average quantum efficiency of 31% and a scattering coefficient at the wavelength of maximum luminescence emission of 0.04/cm. Results of experiments to determine details of the microscopic environment of Cr in mullite glass-ceramics are presented. A computational analysis of the performance of luminescent solar concentrators based on mullite glass-ceramics is described, as are experiments using large pieces of the material which verify the validity of the analysis. DOE

**N87-27039#** California Univ., Berkeley. Lawrence Berkeley Lab.
**ON MECHANICAL BEHAVIOR OF METAL-CERAMIC BONDED SYSTEMS Ph.D. Thesis**
Mei-Chien Lu Apr. 1987 119 p
(Contract DE-AC03-76SF-00098)
(DE87-010818; LBL-23333) Avail: NTIS HC A06/MF A01

A study of the mechanical behavior of metal/ceramic bonded systems is achieved by using a simple model system consisting of two ceramic bodies and a metal interlayer. The mismatch of the material properties across the interface strongly affects the stress fields in the system and thus the mechanical strength. Four important factors determine the mechanical strength of a bonded material: the yield strength of the metal; mismatch of material properties; the dimensionless thickness of the metal, d/h; and the defects at the interface. The finite element method, in conjunction with the virtual extension technique, is used to evaluate the stress fields as well as the strain energy release rate and predict the possible failure strength. Edge-dominated failure is found to be important when the yield strength of metal is large, whereas limit load failure may exist in the metal when the yield strength is small. Reduction of the thickness of the metal diminishes edge stress concentrations and increases the limit load. Residual stresses and the crack blunting induced by metal plasticity also affect the failure. The failure strength of diffusion bonded Al2O3/Au is evaluated by a bending test and the corresponding microstructure at the interface examined by scanning electron microscopy. The effect of the defects at the interface is then related to the stress fields, through the use of failure statistics. A map including the general failure mechanisms is presented to summarize the mechanical behavior of the bonded systems. DOE

**N87-27040#** Ballistic Research Labs., Aberdeen Proving Ground, Md.
**LOW PRESSURE COMPACTION OF SHS (SELF-PROPAGATING HIGH-TEMPERATURE SYNTHESIS) PREPARED CERAMICS**
Michael A. Riley and Andrus Niiler Mar. 1987 28 p
(AD-A180783; AD-E950971; BRL-MR-3574) Avail: NTIS HC A03/MF A01 CSCL 11B

Titanium carbide, Titanium diboride and cermets of these compounds have been synthesized by the Self-Propagating High-Temperature Synthesis (SHS) process. It has been shown, definitively, that the mechanism of Ti+C powders reacting to form TiC is the movement of melted titanium to the solid carbon lattice. Extensive porosity in the product is caused by this movement of the titanium but additional voids are formed from the expulsion of contaminant gases during the combustion process. In order to eliminate these voids and porosity in the material, the reacted samples have been compacted up to pressures of 0.41GPA (60Kpsi) immediately after the completion of the combustion. These products have results in samples with densities greater than 95% and microhardness approaching values obtained by conventional sintering techniques. GRA

**N87-27041#** Massachusetts Univ., Amherst. Dept. of Polymer Science and Engineering.
**STRUCTURE FORMATION IN SOLUTIONS OF RIGID POLYMERS UNDERGOING A PHASE TRANSITION Interim Report, Sep. 1983 - Dec. 1986**
Yachin Cohen Apr. 1987 173 p
(Contract F33615-82-K-5068)
(AD-A181039; AFWAL-TR-87-4030) Avail: NTIS HC A08/MF A01 CSCL 11B

The development of morphology, when solutions of rigid polymers are transformed from the liquid to the solid state, was studied in two particular cases: coagulation of a monodomain nematic solution and gelation of a dilute isotropic solution. Direct observation of the morphology by electron microscopy (E.M.) was augmented by measurements of small-angle X-ray scattering (SAXS). A theoretical framework for the analysis of SAXS measurements from oriented systems using a slit-collimated incident beam was developed. The first case is realized in the coagulation stage of the spinning process of high performance fibers and films from solutions of rigid macromolecules. A monodomain nematic solution of poly (p-phenylene benzobisthiazole) PBT in polyphosphoric acid PPA undergoes a transition to the solid state by the action of a non solvent (water). For the second case, gelation of an isotropic solution of poly (alpha-benzyl-1-glutamate), induced by a decrease in temperature, was studied. GRA

**N87-27042#** CVD, Inc., Woburn, Mass.
**DEVELOPMENT OF AN OPTICAL SURVIVABILITY COATING. PHASE 1 Final Report**
29 Apr. 1987 38 p
(Contract DASG60-86-C-0072)
(AD-A181095; CVD-TR-9076) Avail: NTIS HC A03/MF A01 CSCL 11C

A critical objective of the Strategic Defense Initiative (SDI) is the development of optical, particularly infrared, techniques to detect, acquire and track space objects and ballistic missiles. In order for the infrared (IR) systems to detect these relatively cool objectives at suitable ranges (1000 km or more), it is necessary that they operate at the limit of detectivity. Such high sensitivity makes these systems very vulnerable to laser counter measures. Particularly sensitive are the focal plane detectors, focusing optics and optical coatings, all of which have relatively low, optical coatings, all of which have relatively low, optical damage thresholds. GRA

**N87-27043#** Dayton Univ., Ohio. Research Inst.
**EVALUATION OF 350 F CURING ADHESIVE SYSTEMS ON PHOSPHORIC ACID ANODIZED ALUMINUM SUBSTRATES Interim Report, Sep. 1982 - Jun. 1984**
D. R. Askins and Donald R. Byrge Aug. 1986 125 p
(Contract F33615-84-C-5130)
(AD-A181241; UDR-TR-85-120; AFWAL-TR-86-4039) Avail: NTIS HC A06/MF A01 CSCL 11A

Ten different 350 F (177 C) curing adhesive/primer systems were used to bond phosphoric acid anodized aluminum test specimens. The objective of the program was to compare the compatibility of these adhesive/primer systems, with phosphoric acid anodized and sulfuric/dichromate acid etched aluminum surfaces. All the specimens were prepared by Douglas Aircraft Company during the PABST program and tested at the University of Dayton. Lap shear, peel, and stress-durability tests were carried out. The test results indicated several general types of behavior. Firstly, the predominate failure mode for most of the adhesive/primer systems in all three types of tests was an interfacial failure between the primer and adhesive. Secondly, little to no difference is observed between the results for the anodized and acid/dichromate etched surface treatments, although a few of the specific adhesive/primer/alloy/test type combinations exhibited better or worse properties for one surface type than the other. GRA

**N87-27044#** Army Lab. Command, Watertown, Mass. Material Technology Lab.
**EVALUATION OF RESINS CURED BY ULTRAVIOLET RADIATION AND IN CONJUNCTION WITH FIBER OPTIC SYSTEMS FOR USE IN THE FIELD REPAIR OF COMPOSITE MATERIALS Final Report**
Michael S. Sennett and Stanley E. Wentworth Mar. 1987 16 p
(AD-A181256; MTL-TR-87-15) Avail: NTIS HC A02/MF A01 CSCL 11I

Several commercially available resins designed to be cured with ultraviolet radiation were evaluated with respect to their potential for use in the field repair of composite materials. Thermal and mechanical properties of cured resins were evaluated by DSC and TBA techniques. Some cured resins exhibited physical properties which may be suitable for repair application. None of the tested materials was able to cure when impregnated in woven graphite cloth which strongly attenuates the curing radiation. This prevented the use of fiber optics to cure these systems. GRA

**N87-27045#** Southwest Research Inst., San Antonio, Tex. Dept. of Materials Sciences.
**STUDY OF HIGH TEMPERATURE FAILURE MECHANISMS IN CERAMICS Annual Report, 1 Apr. 1986 - 31 Mar. 1987**
Richard A. Page and James Lankford Apr. 1987 64 p
(Contract F49620-85-C-0073)
(AD-A181266; SwRI-8578/4; AFOSR-87-0738TR) Avail: NTIS HC A04/MF A01 CSCL 11B

This report summarizes the results of a fundamental study involving experimental characterization and analytical modeling of grain boundary cavitation and creep crack growth in ceramics exposed to pure tensile loading. The major experimental techniques employed in the program are the use of small-angle neutron scattering to characterize cavity nucleation and growth and stereoimaging analysis to characterize the stress and strain fields associated with growing creep cracks. The major accomplishments described in the report include the design, construction, and successful testing of a creep apparatus that permits creep testing of ceramics under pure tensile loading, the determination of surface preparation conditions that are adequate for the stereoimaging analysis, and the conduct of a series of creep tests designed to characterize the kinetics of damage accumulation under pure tensile loading. Appended to the report is a manuscript that was prepared during the second year of the program titled Stochastic Aspects of Creep Cavitation in Ceramics. It is anticipated that this manuscript will provide the cornerstone for understanding creep damage and creep crack growth. Of particular interest are the development of a stochastic model of grain boundary sliding and a micromechanical model that relates the cavity nucleation rate to the statistics of grain boundary sliding events. GRA

**N87-27046#** Army Lab. Command, Watertown, Mass. Material Technology Lab.
**STATIC FATIGUE OF A SILICONIZED SILICON CARBIDE Final Report**
George D. Quinn Mar. 1987 21 p
(Contract DE-AIO5-840R-21411)
(AD-A181479; MTL-TR-87-20) Avail: NTIS HC A02/MF A01 CSCL 11B

The static fatigue resistance of a novel siliconized silicon carbide has been evaluated. The material is fabricated by the in-situ reaction of silicon with fine, uniform carbon skeletons produced from liquid polymer solutions. The process has potential to make net shape parts without final machining. A very fine microstructure results, in turn, gives high strength. Flexural specimens tested in this study had high strength at room and elevated temperatures (up to 1300 C), and had good static fatigue and creep resistance. GRA

**N87-27047#** Foster-Miller Associates, Inc., Waltham, Mass.
**ORDERED POLYMER NONLINEAR OPTICAL MATERIALS Final Report, 1 Sep. 1986 - 28 Feb. 1987**
Paul J. Marinaccio and Mark A. Druy Apr. 1987 29 p
(Contract F49620-86-C-0104)
(AD-A181491; AFB-0104-FM-8660-79; AFOSR-87-0628TR)
Avail: NTIS HC A03/MF A01 CSCL 20F

(AD-A181491; AFB-0104-FM-8660-79; AFOSR-87-0628TR)
Avail: NTIS HC A03/MF A01 CSCL 20F

Polyphenylene benzobisthiazole (PBT) has been shown to have a significant third order nonlinear optical effect. Shear orientation, extrusion and quench conditions, post chemical treatments, and post thermal treatments under a variety of conditions all influence the film's nonlinear optical properties. These variables can alter the nonlinear effects since they affect the degree of molecular alignment, the orientation through the film cross section, the degree of crystallinity and the optical quality. In particular, it was found that heat treating the film after extrusion, while improving the mechanical properties, diminished the value of the third order nonlinear optical susceptibility. These results indicate that heat treating may introduce scattering defects into the films causing a decrease in X(3). GRA

**N87-27048#** Massachusetts Inst. of Tech., Cambridge. Dept. of Chemical Engineering.
**A RESEARCH PROJECT ON THE EMULSIFYING AND HOMOGENIZING PROPERTIES OF BLOCK COPOLYMERS IN POLYMER BLENDS Final Report, 1 Jul. 1977 - 30 Apr. 1987**
Robert E. Cohen 15 Jun. 1987 8 p
(Contract N00014-77-C-0311)
(AD-A181602) Avail: NTIS HC A02/MF A01 CSCL 11B

Ten years of research in this laboratory has led to a clear and unified view of the emulsifying or homogenizing role of diblock copolymers in blends of amorphous rubbery polymers. Recent work emphasized that a similar, but more complex set of phenomena may be useful in the manipulation of semicrystalline polymer blend morphologies and properties. The research focused on model polymers comprised of nonpolar hydrocarbon repeat units. The work built on strong capabilities for in-house synthesis of the required homopolymers and diblock copolymers and for molecular, morphological, and mechanical characterization of the selected polymers. GRA

**N87-27049#** California Univ., Berkeley. Lawrence Berkeley Lab.
**MICROANALYSIS OF POLYTYPOID CERAMICS BY IMAGING, DIFFRACTION AND SPECTROSCOPY**
K. M. Krishnan and G. Thomas Feb. 1987 12 p Presented at the Pacific Workshop and Meeting on Analytical Electron Microscopy, Kona, Hawaii, 12 Jul. 1987
(Contract DE-AC03-76SF-00098)
(DE87-007599; LBL-22924; CONF-870733-2) Avail: NTIS HC A02/MF A01

Combined atomic resolution imaging, microdiffraction and energy dispersive X-ray microanalysis suggest that the 32H polytypoid in the AlN-Al2O3 pseudobinary system is in fact a 7:9 periodic intergrowth of the 21R and 27R polytypoids. Furthermore, these combined techniques verify that the cation/anion ratio is 16/17 and that this ratio defines the polytypoid precisely. DOE

**N87-27050#** Oak Ridge National Lab., Tenn.
**STRAIN AND FRACTURE IN WHISKER REINFORCED CERAMICS**
P. Angelini, W. Mader, and P. F. Becher 1986 18 p Presented at the Materials Research Society Fall Meeting, Boston, Mass., 1 Dec. 1986 Prepared in cooperation with Max-Planck-Inst. fuer Metallforschung, Stuttgart, West Germany
(Contract DE-AC05-84OR-21400)
(DE87-010376; CONF-861207-106) Avail: NTIS HC A02

Whisker reinforced ceramics offer the potential for increased fracture strength and toughness. However, residual strain due to the thermal expansion mismatch between Al2O3 and SiC may affect mechanical properties of such composites. Crack tip interaction with the whisker/matrix may lead to changes in debonding behavior or influence other toughening mechanisms. The strain field in the Al2O3 matrix surrounding SiC whiskers was analyzed with a High Voltage Transmission Electron Microscope (HVEM). Strain contrast oscillations indicating the presence of residual stress in the specimen were observed in a Al2O3-5 vol % SiC composite having approx. = 15 micron grain size. The

strain field was found to have both radial (perpendicular to whisker axis) and axial (parallel to whisker axis) components. A strain field was also present near the end faces of SiC whiskers. In situ thermal annealing to 573, 873, and 1173 K showed a decrease in the residual strain while in situ cooling to approx. = 77 K revealed little change in the strain. These results show that residual stresses in the compacts result from differences in thermal expansion and elastic constants of the matrix and whisker materials. Dynamic in situ fracture experiments performed in an HVEM on the Al2O3-5 vol % SiC material having approx. = 15 micron as well as on Al2O3-20 vol % SiC having approx. = 1 micron grain size revealed that fracture resistance is due to a number of mechanisms including debonding near the whisker matrix interface, crack deflection, pinning, and bridging by SiC whiskers. Formation of secondary fractures and microcracks near and in front of propagating crack tips was also observed in the larger grain size composite. DOE

**N87-27051#** Mound Lab., Miamisburg, Ohio.
**CHEMISTRY OF GLASS-CERAMIC TO METAL BONDING FOR HEADER APPLICATIONS. 3: TREATMENT OF INCONEL 718 TO ELIMINATE HOT CRACKING DURING LASER WELDING**
W. E. Modderman, W. H. Jones, T. L. Koeller, S. M. Craven, and D. P. Kramer 24 Apr. 1987 24 p
(Contract DE-AC04-76DP-00053)
(DE87-010639; MLM-3425-3) Avail: NTIS HC A02/MF A01

A study was conducted to determine the weldability of Inconel 718 shells. Two pieces of Inconel 718 were welded together with a Hastelloy B-2 filler. The Inconel surface condition was varied by heat-treating and by using several different cleaning processes. The surface chemistry following each modification was determined by Auger spectroscopy. Each conditioned Inconel hollow cylinder (shell) was also checked for pulsed laser weldability by looking for hot cracking. Abraded and solvent-cleaned Inconel shells were found to have thin surface oxides and were also found to be weldable. Heat-treated shells were shown to have a thick complex oxide layer consisting primarily of chromium, titanium, aluminum, and niobium, and were not found to be weldable. Variations of an oxide removal treatment were used and found to be ineffective in removing all of the heat-treated surface oxides. The predominant oxide left after the various removal treatments was a thick aluminum oxide laced with alkali, alkaline earth and nickel oxides, sulfides (or sulfates), and/or chlorides. Inconel shells after being treated by these oxide removal steps and variations were also found not to be laser weldable. This oxide was finally removed by electropolishing, and the resulting surface was found to be crack-free after welding. Auger analysis of fractured surfaces in hot-cracked regions revealed that the surfaces consisted of an oxide similar to that left after the removal steps, but without the aluminum oxide. Thus, it was concluded that hot cracking in heat-treated, oxide-removed Inconel 718 is due to one or all of the following: alkali, alkaline earth and nickel oxides, sulfides (or sulfates), and/or chlorides that accumulate in the cracked area. DOE

**N87-27052#** Tennessee Univ., Knoxville. Dept. of Chemistry.
**STATISTICAL MECHANICS OF POLYMER SYSTEMS Progress Report, 1 Sep. 1986 - 31 Aug. 1987**
J. Kovac 1 Mar. 1987 9 p
(Contract DE-FG05-84ER-45114)
(DE87-010701; DOE/ER-45114/3) Avail: NTIS HC A02/MF A01

In the original proposal three areas of research were outlined: development of reasonable, but mathematically tractable models for isolated polymer chain dynamics using projection operator techniques; study of the effects of entanglements on the dynamics of polymer chains by means of computer simulation; and non-equilibrium thermodynamic and statistical mechanical theories of the glass transition. In the third year of the grant we have again focused most of our attention on the computer simulation work, but in January we began a serious study of the statistical mechanics of quenched systems. The computer simulation work continues to be fruitful. Collaborative efforts have been initiated to study various aspects of computer simulation of polymer dynamics. DOE

**N87-27053*#** Case Western Reserve Univ., Cleveland, Ohio.
**EXPERIMENTAL EVALUATION OF CHROMIUM-CARBIDE-BASED SOLID LUBRICANT COATINGS FOR USE TO 760 C Final Report**
Christopher DellaCorte Aug. 1987 44 p
(Contracts NCC3-30; DE-AI01-85CE-50162)
(NASA-CR-180808; E-3713; DOE/NASA/0030-2; NAS 1.26:180808) Avail: NTIS HC A03/MF A01 CSCL 11H

A research program is described which further developed and investigated chromium carbide based self-lubricating coatings for use to 760 C. A bonded chromium carbide was used as the base stock because of the known excellent wear resistance and the chemical stability of chromium carbide. Additives were silver and barium fluoride/calcium fluoride eutectic. The three coating components were blended in powder form, applied to stainless steel substrates by plasma spraying and then diamond ground to the desired coating thickness. A variety of coating compositions was tested to determine the coating composition which gave optimum tribological results. Coatings were tested in air, helium, and hydrogen at temperatures from 25 to 760 C. Several counterface materials were evaluated with the objective of discovering a satisfactory metal/coating sliding combination for potential applications, such as piston ring/cylinder liner couples for Stirling engines. In general, silver and fluoride additions to chromium carbide reduced the friction coefficient and increased the wear resistance relative to the unmodified coating. The lubricant additives acted synergistically in reducing friction and wear. Author

**N87-27054*#** National Aeronautics and Space Administration, Washington, D.C.
**STUDIES ON THE DURABILITY OF POLYMER MATERIALS**
Tadashi Shirota Aug. 1987 52 p Transl. into ENGLISH of Kobunshi Zairyo Ni Kansuru Kenkyu, Part 1, Tadashi Shirota, Japan, Kogyo Gijutsuin Kenkyu Hokoku, no. 1, 1981 p 1-13 Transl. by Kanner (Leo) Associates, Redwood City, Calif. Original document prepared by Research Inst. for Polymers and Textiles
(Contract NASw-4005)
(NASA-TT-20082; NAS 1.77:20082) Avail: NTIS HC A04/MF A01 CSCL 11B

In order to establish a comprehensive evaluation system for the durability of polymer materials, this research project was started in fiscal year 1972 with the cooperation of eight institutes affiliated with the Agency of Industrial Science and Technology, and continued seven years. Six polymers, (polystyrene, polyvinyl chloride, polymethyl methacrylate, polyoxymethylene, polyacrylonitrile butadiene sytrene, and polyethylene) were chosen for this purpose. The testing conditions include application of mechanical force, storage at various room temperatures, weathering in four different regions (up to five years), exposure to seven artificial lights, and exposure to heat and chemicals. Tests were made on physical properties (tensile and bending characteristics, impact strength, fatigue, creep) structural factors (erosion, molecular weight, infrared absorption), and apparent features (dimension, shape, weight, luster, color, surface smoothness). Author

# 28 PROPELLANTS AND FUELS

Includes rocket propellants, igniters, and oxidizers; their storage and handling procedures; and aircraft fuels.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *44 Energy Production and Conversion.*

**N87-27055#** Air Force Astrophysics Lab., Edwards AFB, Calif.
**NEW SYNTHETIC TECHNIQUES FOR ADVANCED PROPELLANT INGREDIENTS: TRIFLUOROMETHANESULFONATE DERIVITIVE INTERMEDIATES Final Report, Oct. 1981 - Dec. 1986**
Robert D. Chapman, John L. Andreshak, Scott A. Shackelford, Stephen P. Herrlinger, and Robert A. Hildreth Apr. 1987 31 p
(AD-A180620; AFAL-TR-87-027) Avail: NTIS HC A03/MF A01 CSCL 21I

The metathesis reaction between silver triflate and bromoalkanes potentially offers an attractive synthetic complement to the well known alcohol condensation with triflic anhydride for organic triflate esters. Dibromoalkanes can further give difunctional triflate intermediates and could provide convenient routes to asymmetrically substituted derivatives. Certain shorter members of the alpha,omega-dibromoalkane homologous series display a unique reactivity and product selectivity over higher homologues and corresponding 1 monobromoalkanes. Triflate products from monobromoalkanes and alpha,omega-dibromoalkanes greater than 1,4-dibromobutane can lead to benzene solvent alkylation or polymerization in CC14, but the lower 1,2- through 1,4-dibromoalkanes produce desired monobromoalkyl triflate and alkanediyl ditriflate products under the same reaction conditions. GRA

**N87-27056#** Aerodyne Research, Inc., Billerica, Mass.
**BORON ASSISTED HYDROCARBON COMBUSTION MODEL AND SENSITIVITY ANALYSIS Final Report**
Robert C. Brown, C. E. Kolb, R. A. Yetter, F. L. Dryer, and H. R. Rabitz Mar. 1987 124 p
(Contract F49620-86-C-0087)
(AD-A181504; ARI-RR-580; AFOSR-87-0627TR) Avail: NTIS HC A06/MF A01 CSCL 21B

Solid boron has long been recognized as a potential high volumetric density propellant for volume limited air breathing propulsion systems. However, achieving this potential has proved difficult due to low combustion and heat release efficiencies encountered when solid boron slurries are added to conventionally designed combustors. The combustion of solid boron particles with an oxygen based oxidizer has long been known to be a complex process involving both heterogeneous (gas/solid) and homogeneous (gas/gas) chemical kinetics. The difficulties in achieving the anticipated potential of boron assisted propellants in practical applications has created a need for improved understanding of the basic chemical and physical processes in these systems. GRA

**N87-27057#** Sandia National Labs., Albuquerque, N. Mex.
**THERMAL IGNITION OF Ti-BASED PYROTECHNICS 2: Ti OXIDATION KINETICS APPLIED TO ANALYSIS OF SLOW IGNITION (DTA) EXPERIMENTS**
K. L. Erickson, J. W. Rogers, Jr., and R. D. Skocypec 1987 13 p Presented at the 3rd International Conference of the Groupe de Travail de Pyrotechnic Spatiale and 12th International Pyrotechnics Seminar, Paris, France, 8 Jun. 1987
(Contract DE-AC04-76DP-00789)
(DE87-008643; SAND-86-1652C; CONF-870668-4) Avail: NTIS HC A02/MF A01

A series of slow thermal ignition experiments were conducted with titanium powders to evaluate previously developed titanium oxidation models. Comparison of experimentally observed and theoretically predicted powder response indicated that the oxidation models predicted reaction rates consistent with those required for ignition. However, reaction rates appear also to be dependent on additional mechanisms, which must be determined to develop generally applicable models. DOE

**N87-27058#** Mound Lab., Miamisburg, Ohio.
**A MICROCALORIMETER USED TO DETECT CHANGES IN AGED ENERGETIC MATERIALS**
C. J. Wiedenheft, W. W. Rodenburg, and G. C. Shockey 1987 4 p Presented at the 14th Department of Energy Compatibility, Aging and Service Life Conference, Amarillo, Tex., 28 Apr. 1987
(Contract DE-AC04-76DP-00053)
(DE87-009201; MLM-3434(OP); CONF-870482-5) Avail: NTIS HC A02/MF A01

To ensure the quality of chemical explosives, analytical tests are performed on the materials. One of the most fundamental measurements is that of heat released during an exothermic reaction. Because only small amounts, less than 20 mg, of explosive material can be removed from most weapons, special techniques and instruments must be used to measure a heat output of a few tens of calories. The calorimeter described in this report consists of a sample side and a reference side placed in a constant temperature bath. The calorimeter and sample are heated by passing the current from a bank of capacitors through a heating wire. In order to measure the temperature change, the resistance of Ni wire is measured. The unit was calibrated and found to be accurate for reactions with greater than 5 calories of heat output. DOE

**N87-27059*#** National Aeronautics and Space Administration, Washington, D.C.
**STUDIES OF SOLID PROPELLANT COMBUSTION WITH PULSED RADIOGRAPHY**
T. Godai, T. Tanemura, T. Fujiwara, and M. Shimizu Aug. 1987 31 p Transl. into ENGLISH OF Parusu Xsen Kanketsu Syashinho Niyoru Kotai Puroperanto no Nensyou Nikansuru Kenkya, Tokyo, Japan, National Aerospace Lab., Sept. 1978 Original language document was announced as N79-77192 Transl. by Kanner (Leo) Associates, Redwood City, Calif. Original document prepared by Aerospace Research Group
(Contract NASw-4005)
(NASA-TT-20081; NAS 1.77:20081) Avail: NTIS HC A03/MF A01 CSCL 21I

Pulsed radiography was applied to observe solid propellant surface regression during rocket motor operation. Using a 150 KV flash X-ray system manufactured by the Field Emission Corporation and two kinds of film suppliers, images of the propellant surface of a 5 cm diameter end burning rocket motor were recorded on film. The repetition frame rate of 8 pulses per second and the pulse train length of 10 pulses are limited by the capability of the power supply and the heat build up within the X-ray tube, respectively. The experiment demonstrated the effectiveness of pulsed radiography for observing solid propellant surface regression. Measuring the position of burning surface images on film with a microdensitometer, quasi-instantaneous burning rate as a function of pressure and the variation of characteristic velocity with pressure and gas stay time were obtained. Other research items to which pulsed radiography can be applied are also suggested. Author

# 29 MATERIALS PROCESSING

Includes space-based development of products and processes for commercial applications.

For biological materials see *55 Space Biology.*

No abstracts in this category.

# 31 ENGINEERING (GENERAL)

Includes vacuum technology; control engineering; display engineering; cryogenics; and fire prevention.

**N87-27060#** Vibration Inst., Clarendon Hills, Ill.
**THE SHOCK AND VIBRATION DIGEST, VOLUME 18, NO. 12 Monthly Report**
Judith Nagle-Eshleman, ed. Dec. 1986 175 p
(AD-A177379) Avail: NTIS HC A08/MF A01

Research of interest to the Shock and Vibration scientific research community is presented. The two feature articles are entitled: (1) Mechanical Signature Analysis, and (2) Fracture Analysis. Also presented are book reviews, current news, and abstracts from the current literature. For individual titles, see N87-27061 through N87-27062.

**N87-27061#** Vermont Univ., Burlington.
**MECHANICAL SIGNATURE ANALYSIS** **c37**
M. S. Hundal *In* Vibration Inst., The Shock and Vibration Digest, volume 18, no. 12 Dec. 1986 p 3-10 (For primary document see N87-27060 21-31)
Avail: NTIS HC A08/MF A01

Literature on mechanical signature analysis (MSA) for 1983 to 1985 is reviewed. MSA applications discussed include analytical and experimental methods, programs, and systems for machinery and process monitoring and diagnosis. Author

**N87-27062#** FractuResearch, Inc., Galena, Ohio.
**FRACTURE ANALYSIS: A REVIEW** **c39**
D. Broek *In* Vibration Inst., The Shock and Vibration Digest, volume 18, no. 12 Dec. 1986 p 13-22 (For primary document see N87-27060 21-31)
Avail: NTIS HC A08/MF A01

A review of practical methods for fracture mechanics analysis is presented. Linear elastic methods can yield useful results. Elastic-plastic methods are becoming useful with the development of single expressions for J that contain only one geometry factor. Present limitations are due only to limited availability of geometry factors. Author

**N87-27063#** Massachusetts Inst. of Tech., Cambridge. Cryogenic Engineering Lab.
**EXPERIMENTAL INVESTIGATION OF A MAGNETIC REFRIGERATOR BASED ON MAGNETICALLY ACTIVE REGENERATION Final Report, May 1984 - May 1986**
Yukikazu Iwasa, Joseph L. Smith, Jr., and Carl P. Taussig Mar. 1987 131 p
(Contract F33615-84-C-3402)
(AD-A180991; AFWAL-TR-86-3113) Avail: NTIS HC A07/MF A01 CSCL 20M

The concept of magnetically active regeneration is explored in a prototype magnetic refrigerator which has produced a refrigeration of 0.40 W at 3.79 K while rejecting 3.0 W to a 5.51 K sink. The prototype refrigerator consists of a Gadolinium-Gallium-Garnet (Gd3Ga5O12)regenerator core excited by an AC superconducting solenoid. A reversing flow of 3 atm supercritical helium carries the heat of magnetization to the hot reservoir and refrigerates the cold reservoir with the cooling of demagnetization. GRA

**N87-27064#** Naval Research Lab., Washington, D.C.
**MICROSENSOR MONITORING OF ENGINE LUBRICANTS FOR FUEL DILUTION AND WATER CONTENT Memorandum Report, Apr. 1984 - Oct. 1986**
Robert N. Bolster 20 May 1987 25 p
(AD-A181287; NRL-MR-5961) Avail: NTIS HC A02/MF A01 CSCL 09A

A laboratory device has been developed to examine diesel engine lubricants for fuel dilution. Samples of 25 microliters were heated in flowing air, and the volatiles evolved detected with a calibrated electronic sensor. With suitable temperatures and flow rates, determined from tests of typical lubricants and fuels, dilution of 1% was readily detectable. The quantitative precision of the method was affected by the varied oil volatilities, but was limited by the stability of the semiconductor sensor. Moisture sensitivity, flow rate sensitivity, and slowness in returning to its baseline level after use were encountered. A surface acoustic wave fuel sensor might offer improved performance. The detection of small quantities of water in lubricants by this method is difficult, due to the small sample volume and interference by the organic vapors, but should be possible with sensors. GRA

**N87-27065#** Aeronautical Research Labs., Melbourne (Australia).
**A MULTI-PROCESSOR SLAVE PERIPHERAL CONTROLLER Aerodynamics Technical Memorandum**
J. F. Harvey Nov. 1986 38 p
(AD-A181311; ARL-AERO-TM-385) Copyright Avail: NTIS HC A03/MF A01 CSCL 13H

An intelligent peripheral controller is described. The controller operates as a slave processor in a multiple processor environment. The system utilizes Motorola MC68000 microprocessors operating on VME bus and Eurocard construction. Each slave processor is totally self contained with individual bus buffering, memory and input/output. Multiple slave processors connect to a common VME bus operating under the control of a master microprocessor. The master may operate under its own resident program or under the direct control of an external host computer. Passing of programs (algorithms) and exchange of data to this slave are controlled by the master until again interrupted. Each slave, although capable of independent operation, may operate as a synchronous or asynchronous system under hand shake control with the master or other slaves. The system was originally designed to control high speed (10,000 step/second) stepper motors to position a six degrees of freedom, hot wire anemometer probe. GRA

**N87-27066#** Wayne State Univ., Detroit, Mich. Dept. of Electrical and Computer Engineering.
**FLOWING AFTERGLOW VAPOR DEPOSITION FOR MICROELECTRIC APPLICATIONS Final Report, Jan. 1985 - Apr. 1987**
Drew Buchanan 28 Apr. 1987 42 p
(Grant AF-AFOSR-0131-85)
(AD-A181644; AFOSR-87-0728TR) Avail: NTIS HC A03/MF A01 CSCL 20I

The construction of a novel type of plasma assisted chemical vapor deposition device for microelectronic applications has been completed. The machine is based on a flowing afterglow system in which the source generation plasma is physically decoupled from the deposition substrate. Because of the high gas throughout the machine can operate not only as a novel plasma assisted CVD region system, but as a physical deposition device as well. The combination of physical deposition capabilities, versatile plasma capabilities, and nor CVD capabilities, suggests unusual flexibility in the production of high quality insulating films for indium phosphide based microelectronic structures. The achievement of high quality insulating layers on indium phosphide substrates could lead to the development of indium phosphide based metal-insulator-semiconductor (MIS) devices. The MIS structure might eventually be utilized for very high speed VLSI applications. The devices should be able to achieve operating speeds in the 100 GHz regions and beyond. Initial efforts have thus far proved unsuccessful in obtaining high quality films, although the system still shows promise for circumventing the limitation of other deposition techniques. GRA

**N87-27067*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
**EXACT STATE RECONSTRUCTION IN DETERMINISTIC DIGITAL CONTROL SYSTEMS**
Michael E. Polites Aug. 1987 19 p
(NASA-TP-2757; NAS 1.60:2757) Avail: NTIS HC A02/MF A01 CSCL 13H

A state reconstructor for deterministic digital systems is presented which is ideal in the following sense: if the plant parameters are known exactly, the output of the state reconstructor

will exactly equal the true state of the plant, not just approximate it. Furthermore, this ideal state reconstructor adds no additional states or eigenvalues to the system. Nor does it affect the plant equation for the system in any way; it affects only the measurement equation. While there are countless ways of choosing the ideal state reconstructor parameters, two distinct methods are described here. An example is presented which illustrates the procedures to completely design the ideal state reconstructor using both methods. Author

**N87-27212*#** Vanzetti Systems, Inc., Stoughton, Mass.
**INTELLIGENT LASER SOLDERING INSPECTION AND PROCESS CONTROL**
Riccardo Vanzetti *In* NASA. Langley Research Center, Electronics Reliability and Measurement Technology Aug. 1987 p 85-94
(For primary document see N87-27204 21-38)
Avail: NTIS HC A07/MF A01 CSCL 13H

# 32 COMMUNICATIONS AND RADAR

Includes radar; land and global communications; communications theory; and optical communications.

For related information see also *04 Aircraft Communications and Navigation* and *17 Space Communications, Spacecraft Communications, Command and Tracking.* For search and rescue see *03 Air Transportation and Safety,* and *16 Space Transportation.*

**N87-27068*#** Arizona State Univ., Tempe. Dept. of Electrical and Computer Engineering.
**ELECTROMAGNETIC BACKSCATTERING BY PLATES AND DISKS Semiannual Report, 1 Aug. 1986 - 31 Jan. 1987**
Constantine A. Balanis, Timothy Griesser, and Diane M. Marsland 2 Feb. 1987 43 p
(Grant NAG1-562)
(NASA-CR-180643; NAS 1.26:180643) Avail: NTIS HC A03/MF A01 CSCL 20N

With the recent development of diffraction coefficients for imperfectly conducting half-planes, it has become possible to analyze a wide variety of problems for which the impedance surface boundary condition applies. This impedance boundary condition, while approximate, was utilized to extend the usefulness of the Uniform Geometrical Theory of Diffraction (UTD) beyond the perfectly conducting geometries. These half-plane diffraction coefficients are used to analyze patterns of an antenna in the presence of an imperfectly conducting flat polygonal plate. The Geometrical Theory of Diffraction (GTD) techniques were also used to investigate the backscattering from perfectly conducting plates. To further improve the soft polarization results for wide angles, a model for the creeping wave or circulating current on the edge of the disk was obtained and used to find an additional component of the backscattered field. The backscattering from a square plate was then analyzed using GTD. Backscattering in both the principal and off-principal planes was examined. Author

**N87-27069*#** Ohio State Univ., Columbus. Dept. of Electrical Engineering.
**RADAR CROSS SECTION STUDIES Final Report**
W. D. Burnside, A. K. Dominek, I. J. Gupta, E. H. Newman, P. H. Pathak, and L. Peters, Jr. May 1987 57 p
(Grant NsG-1613)
(NASA-CR-181104; NAS 1.26:181104; FR-716148-21) Avail: NTIS HC A04/MF A01 CSCL 17E

The ultimate goal is to generate experimental techniques and computer codes of rather general capability that would enable the aerospace industry to evaluate the scattering properties of aerodynamic shapes. Another goal involves developing an understanding of scattering mechanisms so that modification of the vehicular structure could be introduced within constraints set by aerodynamics. The development of indoor scattering measurement systems with special attention given to the compact range is another goal. There has been considerable progress in advancing state-of-the-art scattering measurements and control and analysis of the electromagnetic scattering from general targets. Author

**N87-27070#** RAND Corp., Santa Monica, Calif.
**ISSUES IN INTERNATIONAL TELECOMMUNICATIONS: GOVERNMENT REGULATION OF COMSAT**
Leland L. Johnson Jan. 1987 70 p Sponsored by The John and Mary R. Markle Foundation
(R-3497-MF; ISBN-0-8330-0798-X) Avail: NTIS HC A04/MF A01

The history of government regulations are traced. The difficulties of designing and enforcing an effective regulatory scheme is discussed and whether regulation should be restructured or abandoned within the rapidly changing economic environment is evaluated. B.G.

**N87-27071#** Oak Ridge National Lab., Tenn. Fuel Recycle Div.
**EVALUATION OF HIGH-DEFINITION TELEVISION FOR REMOTE TASK PERFORMANCE**
J. V. Draper, Y. Fujita (Power Reactor and Nuclear Fuel Development Corp., Tokyo, Japan ), and J. N. Herndon Apr. 1987 28 p
(Contract DE-AC05-84OR-21400)
(DE87-009784; ORNL/TM-10303) Avail: NTIS HC A03/MF A01

High-definition television (HDTV) transmits a video image with more than twice the number (1125 as against 525) of horizontal scan lines that standard-resolution TV provides. The improvement in picture quality that the extra scan lines provide is impressive. Objects in the HDTV picture have more sharply defined edges, better contrast, and more accurate reproduction of shading and color patterns than do those in the standard-resolution TV picture. Because the TV viewing system is a key component for teleoperator performance, an improvement in TV picture quality could mean an improvement in the speed and accuracy with which teleoperators perform tasks. This report describes three experiments designed to evaluate the impact of HDTV on the performance of typical remote tasks. The performance of HDTV was compared to that of standard-resolution, monochromatic TV and standard-resolution, stereoscopic, monochromatic TV in the context of judgment of depth in a televised scene, visual inspection of an object, and performance of a typical remote handling task. The results of the three experiments show that in some areas HDTV can lead to an improvement in teleoperator performance. Observers inspecting a small object for a flaw were more accurate with HDTV than with either of the standard-resolution systems. High resolution is critical for detection of small-scale flaws of the type in the experiment (a scratch on a glass bottle). These experiments provided an evaluation of HDTV television for use in tasks that must be routinely performed to remotely maintain a nuclear fuel reprocessing facility. DOE

**N87-27072#** Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
**IMPLEMENTATION OF A ROBUST 2400 b/s LPC ALGORITHM FOR OPERATION IN NOISY ENVIRONMENTS**
Elliot Singer and Joseph Tierney 1 Apr. 1987 24 p
(Contract F19628-85-C-0002)
(AD-A180644; TR-766; ESD-TR-86-166) Avail: NTIS HC A02/MF A01 CSCL 20D

A detailed description of the implementation of a robust 2400 b/s LPC algorithm is presented. The algorithm was developed to improve vocoder performance in acoustically compromised environments. Improved robustness in noise is achieved by: (1) increasing the speech bandwidth to 5 kHz; (2) increasing the LPC model order to 12; and (3) doubling the analysis rate. Frame fill techniques are used to achieve the 2400 b/s data rate. The algorithm is embodied in the Advanced Linear Predictive Coding Microprocessor which was developed as a prototype voice processor for in-flight evaluation of narrowband voice communication in the JTIDS communication system. GRA

**N87-27073#** Naval Research Lab., Washington, D.C.
**GROUND-WAVE PATH LOSS OVER ICE-COVERED SEA AT FREQUENCIES BETWEEN 0.1 AND 10 MHz Interim Report, Jan. - Jul. 1986**
Edward J. Kennedy 6 May 1987 32 p
(AD-A180819; NRL-9041) Avail: NTIS HC A03/MF A01 CSCL 20N

The ground-wave attenuation function has been studied for an involving propagation over an ice-covered sea surface. A review of the techniques that can be used in the analysis of a multilayer ground is presented, and a number of practical sea-ice paths are evaluated numerically. Results are presented for the 0.1 to 10 MHz frequency range and consist of curves showing propagation loss as a function of distance for various ice thicknesses. It is shown that the variation of the attenuation function with distance and with frequency is significantly different than for the open ocean case. A range of frequencies over which path loss is predicted to be less than for seawater only is dependent on the path length and is shown to lie in the medium frequency range. GRA

**N87-27074#** Royal Signals and Radar Establishment, Christchurch (England).
**THE NEW GENERATION OF 673 KELVIN MICROWAVE NOISE STANDARDS**
A. M. Wallace Feb. 1987 15 p
(AD-A180861; RSRE-MEMO-4025; DRIC-BR-102008) Avail: NTIS HC A02/MF A01 CSCL 17I

A new generation of waveguide microwave noise standards is now in service. The general outlines of the design are sufficiently well established to make the production of similar standards operating between 2 and 40 GHz, in wavebands other than those mentioned, largely a matter of routine. The existing standards are an improvement on the previous generation because they have been more fully investigated thermally, are demountable and most important of all are essentially broadband. GRA

**N87-27075#** Army Cold Regions Research and Engineering Lab., Hanover, N. H.
**ELECTROMAGNETIC PROPERTY TRENDS IN SEA ICE, PART 1**
Austin Kovacs, Rexford M. Morey, Gordon F. Cox, and Nicholas C. Valleau Apr. 1987 56 p
(Contracts DE-A121-83MC-20022; MIPR-Z51100-5-00004)
(AD-A180929; CREEL-87-6-Pt-1) Avail: NTIS HC A04/MF A01 CSCL 08L

Two-phase dielectric mixing model results are presented showing the electromagnetic properties of sea ice versus depth. The modeled data are compared with field measurements and show comparable results. It is also shown how the model data can be used in support of impulse radar and airborne electromagnetic remote sensing of sea ice. Examples of the remote measurement of sea ice thickness using impulse radar operating in the 80 to 300 MHz frequency band and low-frequency (500 to 30,000 Hz) sounding techniques are presented and discussed. GRA

**N87-27076#** Naval Postgraduate School, Monterey, Calif.
**A STUDY OF DIRECTIONAL AND FREQUENCY PROPERTIES OF SHADED AND PHASED SIMPLE ARRAYS M.S. Thesis**
Young S. Park Dec. 1986 72 p
(AD-A181014) Avail: NTIS HC A04/MF A01 CSCL 20N

Computer programs are designed to calculate and display beam patterns in both two and three dimensions. Graphical presentation and evaluation in three-dimensions are difficult and important problems. Five computer models are presented and used in investigating the directional and frequency properties of shaded and phased doublet, triplet and quadruplet arrays. Comparisons associated with parameters such as wavelength, inter-source distance, source strength, and phase difference are examined. GRA

**N87-27077#** Communications Research Centre, Ottawa (Ontario).
**A METHOD FOR COMBATING FADING MULTIPATH CONDITIONS IN A DIRECT-SEQUENCE SPREAD-SPECTRUM SYSTEM**
Gerald O. Venier Jun. 1986 42 p
(AD-A181144; CRC-1414) Avail: NTIS HC A03/MF A01 CSCL 20N

The large bandwidth of a direct-sequence spread-spectrum communications system provides increased time-delay resolution which can resolve multipath components that would not be resolved by the system without spreading. However, normal direct-sequence systems do not fully exploit this capability. In these systems the received signal is despread by correlation with the reference signal (the spreading waveform) at a single delay. In a multipath situation where there are multiple resolvable delays, one of these delays must be chosen for the correlation. If the path with that delay is fading then the signal may be lost at times, even when a strong signal exists at a different delay. In the system proposed here the despreading correlation is performed at a number of delays and the results are combined to provide the improvement expected from a diversity system under fading multipath conditions. The combining is simplified by the use of differential-phase-shift modulation of the data. An added advantage of the proposed system is that the outputs of the multiple-delay correlator are ideal inputs to a simple but effective code-delay tracking system based on keeping the center of gravity of the values in the correlation window centered in the window. GRA

**N87-27078#** Pennsylvania Univ., Philadelphia. Electro-Optics and Microwave-Optics Lab.
**RESEARCH IN IMAGE UNDERSTANDING AS APPLIED TO 3-D MICROWAVE TOMOGRAPHIC IMAGING WITH NEAR OPTICAL RESOLUTION Final Report, 1 Aug. 1980 - 31 Dec. 1986**
Nabil H. Farhat Mar. 1987 169 p
(Grant AF-AFOSR-0240-81)
(AD-A181252; EO/MO-10; AFOSR-87-0741TR) Avail: NTIS HC A08/MF A01 CSCL 17I

Our research in high resolution microwave imaging shows that massive amounts of information about a scattering object can be gathered by measurements that combine angular, spectral and polarization diversity and trade-offs between spectral and angular degrees of freedom can be used to enhance cost effectiveness of microwave diversity imaging systems. The data collected can be used to access the 3-D Fourier space or p-space of the scatterer which can be Fourier inverted to yield 3-D image information either projectively or tomographically (in slices or cross-sectional outlines when the object is metallic). This indicates that three-dimensional microwave imaging of distant aerospace targets at resolutions comparable or exceeding the capabilities of optical imagers (whose operation is severely degraded by atmospheric effects) is feasible. The aim of research described in this report was to attain new levels of image understanding that are useful in the study and demonstration of 3-D microwave remote imaging with near optical resolution or better. GRA

**N87-27079#** SRI International Corp., Menlo Park, Calif.
**PHASE SCINTILLATION UNDER WEAK AND STRONG SCATTER CONDITIONS Technical Report, 13 Mar. 1985 - 30 Sep. 1986**
Robert C. Livingston and Teri M. Dabbs 30 Sep. 1986 40 p
(Contract DNA001-85-C-0062)
(AD-A181333; DNA-TR-86-333) Avail: NTIS HC A03/MF A01 CSCL 20N

Equatorial observations from the DNA Wideband satellite have been analyzed to: (1) characterize the two component phase spectral form, and (2) estimate the effects of diffraction on the phase spectrum during strong scatter conditions. The average two component phase spectrum has a low frequency dependence of 1/f to the 2.3 power, and 1/f to the 3.9 power at high frequencies. These regimes are separated by a spectral break at about 650m. For weak scatter levels up to S sub 4 greater than or = 0.5, diffraction errors are less than one radian, and phase spectral

shape is independent of carrier frequency. At higher S sub 4 values, the spectrum is affected by diffraction at all spatial frequencies and its shape depends on carrier frequency. GRA

**N87-27080#** Georgia Inst. of Tech., Atlanta. School of Electrical Engineering.
**TWO-DIMENSIONAL SIGNAL PROCESSING AND STORAGE AND THEORY AND APPLICATIONS OF ELECTROMAGNETIC MEASUREMENTS Annual Report, 1 Jan. - 31 Dec. 1986**
R. W. Schafer and D. T. Paris 1 Jan. 1987 47 p
(Contract DAAG29-84-K-0024)
(AD-A181398) Avail: NTIS HC A03/MF A01 CSCL 09E

This is an annual report on research conducted under the auspices of the Joint Services Electronics Program. Specific topics covered are: digital signal processing, parallel processing architectures, two-dimensional optical storage and processing, hybrid optical/digital signal processing, electromagnetic measurements in the time domain, and automatic radiation measurements for near-field and far-field transformations. GRA

**N87-27081#** Communications Research Centre, Ottawa (Ontario). Radar and Communications Technology Branch.
**S-BAND ADAPTIVE RADAR SYSTEM**
A. L. Poirier Jan. 1987 32 p
(AD-A181424; CRC-1417) Avail: NTIS HC A03/MF A01 CSCL 17I

An experimental S band phased array radar system is described. The system was developed to provide experimenters with a means of acquiring real time radar data for on line or off line analysis and to establish a test bed for new experimental devices or data processing techniques. The system is built in modular form, thus allowing various parts of the system to be easily interchanged with experimental devices. It is linked to a 11/780 VAX computer which allows data to be transferred from the radar to the VAX in real time, or to be stored in high speed buffers and then transferred in blocks directly from the buffers to the VAX. The experimenter, using the VAX, can adaptively control the radar, request new beam directions, control data acquisition, etc., via the link. GRA

**N87-27082#** Naval Postgraduate School, Monterey, Calif.
**ANTI-SKYWAVE AM BROADCAST ANTENNA DESIGN M.S. Thesis**
Sarfraz Hussain Mar. 1987 180 p
(AD-A181559; NPS62-87-009) Avail: NTIS HC A09/MF A01 CSCL 20D

This thesis investigates the design of an anti-skywave (ASW) AM broadcast antenna. The parameters of a typical AM broadcast antenna are presented first. Then the design proposed is studied by numerical modeling with the Numerical Electromagnetic Code (NEC). Biby's proposed design involves a ring of short radiators with a conventional monopole operating over finite ground. To analyze the behavior of Biby's proposed ASW antenna, a generic radiator study is conducted to test the ability of different sized radiators to launch the sky wave and the ground wave first as isolated elements and then as closely coupled radiators with cancelling phasing. Finally, some potential candidate structures are proposed for AM broadcast transmission which might achieve the desired characteristics of ground wave enhancement and sky wave suppression. GRA

**N87-27083#** Naval Ocean Systems Center, San Diego, Calif.
**PRELIMINARY DESIGN OPTIONS FOR METEOR BURST COMMUNICATIONS SYSTEMS BUOY RELAYS Final Report, Feb. - Aug. 1985**
John E. Bickel, Tedd L. Wright, Eric A. Thowless, Gary L. Davis, and George Pickins Dec. 1986 137 p
(AD-A181738; NOSC/TR-1150) Avail: NTIS HC A07/MF A01 CSCL 17B

This report contains an analysis and evaluation of design options associated with developing a Meteor Burst Communications Systems (MBCS) buoy relay, including antennas and power supplies, that meet various operational requirements. GRA

**N87-27084#** Naval Postgraduate School, Monterey, Calif.
**A STUDY OF LF (LOW FREQUENCY) TOP-LOADED MONOPOLE ANTENNAS USING NUMERICAL MODELING TECHNIQUES. COMPARISON TO SCALED TEST MODEL MEASUREMENTS M.S. Thesis**
Riaz Mahmud Mar. 1987 68 p
(AD-A181796; NPS-62-87-010) Avail: NTIS HC A04/MF A01 CSCL 19A

This thesis studies the electrical properties of a low frequency top-loaded monopole antenna. Several configurations of the antenna are developed using numerical modeling techniques. The electrical properties are calculated and compared with a set of measurements of a scaled test model. The results are presented in the form of design curves and comparison tables. It is important for the U.S. Navy to have a reliable VLF and LF communication systems for world wide coverage. A need exists to increase the power handling capacity and the bandwidth of the existing VLF-LF antenna systems. This study provides the validation of numerical modeling techniques for future simulation of VLF antennas with corona rings. This will permit the design of improvements in the power handling capability by extending the onset of corona.
Author (GRA)

**N87-27085*#** Illinois Univ., Urbana-Champaign. Electromagnetics Lab.
**REDUCTION OF THE RADAR CROSS SECTION OF ARBITRARILY SHAPED CAVITY STRUCTURES**
R. Chou, H. Ling, and S. W. Lee Aug. 1987 130 p
(Grant NAG3-475)
(NASA-CR-180307; NAS 1.26:180307; UILU-ENG-87-2560; UILU-TR-87-6) Avail: NTIS HC A07/MF A01 CSCL 20N

The problem of the reduction of the radar cross section (RCS) of open-ended cavities was studied. The issues investigated were reduction through lossy coating materials on the inner cavity wall and reduction through shaping of the cavity. A method was presented to calculate the RCS of any arbitrarily shaped structure in order to study the shaping problem. The limitations of this method were also addressed. The modal attenuation was studied in a multilayered coated waveguide. It was shown that by employing two layers of coating, it was possible to achieve an increase in both the magnitude of attenuation and the frequency band of effectiveness. The numerical method used in finding the roots of the characteristic equation breaks down when the coating thickness is very lossy and large in terms of wavelength. A new method of computing the RCS of an arbitrary cavity was applied to study the effects of longitudinal bending on RCS reduction. The ray and modal descriptions for the fields in a parallel plate waveguide were compared. To extend the range of validity of the Shooting and Bouncing Ray (SBR) method, the simple ray picture must be modified to account for the beam blurring. B.G.

**N87-27086#** Royal Aircraft Establishment, Farnborough (England).
**THE RECTANGULAR MESH AND THE VARIABLE-SIZE MESH PROCESS IN THE TWO-DIMENSIONAL TLM METHOD**
P. Saguet and E. Pic Apr. 1986 9 p Transl. into ENGLISH from Electronics Letters (France), v. 17, no. 7, 1981 p 277-279
(RAE-Trans-2152) Copyright Avail: NTIS HC A02/MF A01

The introduction of rectangular meshes, and of a variable-size mesh process, in the original two-dimensional transmission-line matrix (TLM) method, leads to a dramatic reduction of computer CPU time for many problems. The theory of these modifications is given, as are some results for fin-line structures. Author

**N87-27087#** Texas Univ., El Paso. Dept. of Electrical Engineering.
**THE INPUT IMPEDANCE OF PROBE FED RECTANGULAR CAVITY WHICH FEEDS INTO A PLASMA COVERED CYLINDRICAL BODY**
J. M. Jarem 1986 10 p Presented at the Antennas and Propagation Society Symposium, Blacksburg, Va., 15 Jun. 1987
(Contract DE-AC04-76DP-00789)
(DE87-003032; SAND-86-2785C; CONF-870655-1) Avail: NTIS HC A02/MF A01

(DE87-003032; SAND-86-2785C; CONF-870655-1) Avail: NTIS HC A02/MF A01

An important problem in the area of antenna theory is the problem of determining the input impedance and antenna characteristics of a probe-fed cavity-aperture antenna which is flush mounted on a conical or cylindrical body and covered by an inhomogeneous plasma sheath. This paper presents an analysis and solution to the above problem when a cylindrical body covers the plasma aperture. The formulation of the equations which describes the electromagnetic fields is based on use of Green's functions and application of the appropriate boundary conditions. Once the electric field is determined, the input impedance of the antenna system is found. Example calculations are made, and the impedance for different frequencies are compiled in the report. DOE

**N87-27088#** Los Alamos National Lab., N. Mex.
**MICROWAVE-INDUCED AIR BREAKDOWN IN A FREE AIR GEOMETRY**
W. T. Armstrong, R. A. Roussel-Dupre, R. Karl, M. I. Buchwald, and G. Graham 1987 3 p Presented at the 18th International Conference on Phenomena in Ionized Gases, Swansea, England, 13 Jul. 1987 Prepared in cooperation with Edgerton, Germeshausen and Grier, Inc., Los Alamos, N. Mex.
(Contract W-7405-eng-36)
(DE87-005105; LA-UR-87-150; CONF-870723-1) Avail: NTIS HC A02

We report on trial experiments, using an open geometry, to measure the breakdown behavior of short, intense microwave pulses in low pressure air. DOE

**N87-27089#** Lawrence Livermore National Lab., Calif.
**COMPUTATIONAL ISSUES IN ELECTROMAGNETIC COUPLING TO A SLIT CYLINDER ENCLOSING AN OFF-SET CYLINDER**
R. F. Schmucker and R. W. Ziolkowski Jan. 1987 11 p Presented at the ARRAY Conference, Montreal, Canada, 26 Apr. 1987
(Contract W-7405-eng-48)
(DE87-006686; UCRL-95835; CONF-870487-1) Avail: NTIS HC A02/MF A01

The canonical scattering and aperture coupling problem of a plane wave incident upon a slit cylinder enclosing another off-set cylinder has been analytically solved using a dual series approach. The solution expressions are nested sums involving Bessel functions. Numerical evaluation of the physical quantities of interest (bistatic radar cross sections, induced currents, and induced fields) typically requires Bessel functions for thousands of arguments, and several hundred orders at each argument. Thus, the execution time of the Bessel function routines becomes critical. A comparison of the timing and accuracy of the new FPS Bessel function software with other non FPS Bessel function routines will be given. In addition, there are two major considerations in developing graphics post processing routines to display the solutions which result from this modeling. First, there is a large number of different system geometries and incident field conditions to model, each with its own computed solutions. Secondly, cross comparisons of different physical quantities are desired to help develop an understanding of the relevant physics. These post processing needs have required the development of several new graphics display methods. A variety of examples from this canonical coupling problem will be given to demonstrate the efficacy of these graphical display routines. DOE

**N87-27090#** Lawrence Livermore National Lab., Calif.
**AN ANTENNA ENGINEERING HANDBOOK FOR ARMY AND MARINE FIELD COMMUNICATION APPLICATIONS**
J. K. Breakall, E. E. Domning, A. M. Christman, W. P. Averill, and J. McDonald Feb. 1987 6 p Presented at the Antennas and Propagation Society Symposium, Blacksburg, Va., 15 Jun. 1987 Prepared in cooperation with Naval Academy, Annapolis, Md. and Army Strategic Communications Command, Fort Huachuca, Ariz.
(Contract W-7405-eng-48)
(DE87-007055; UCRL-96274; CONF-870655-3) Avail: NTIS HC A02

There is currently interest in modeling various antennas chosen to be used in field communication scenarios in the HF range by both the Army and Marine Corps. An engineering antenna handbook and computer database program has been produced at LLNL which will be used in producing an ultimate field antenna handbook. A host of antenna types and configurations have been studied for characteristics which can be used for optimizing best performance when interfaced with existing propagation codes and models. A parameter variation study has been undertaken with frequencies varied from 2 to 30 MHz and ground conductivities and dielectric constants varied for all possible ground conditions. Antenna parameters such as length, height, number of wires, ground stake length, and screen radius variation about some nominal have been looked at. Figures of merit have been devised for both surface and sky wave propagation. Various ways of presenting final results have been explored such as tables, graphs, databases, and parametric lookup tables. DOE

**N87-27091#** Lawrence Livermore National Lab., Calif.
**A FINITE DIFFERENCE APPROACH TO MICROSTRIP ANTENNA DESIGN**
M. J. Barth, R. M. Bevensee, and S. T. Pennock Dec. 1986 5 p Presented at the Antennas and Propagation Society Symposium, Blacksburg, Va., 15 Jun. 1987
(Contract W-7405-eng-48)
(DE87-007324; UCRL-95872; CONF-870655-4) Avail: NTIS MF A01

Microstrip antennas have received increased attention in recent years, due to their size and cost advantages. Analysis of the microstrip structure has proved difficult due to the presence of the dielectric substrate, particularly for complex geometries. One possible approach to a solution is the use of a finite difference computer code to model a proposed microstrip antenna design. The models are easily constructed and altered, and code versions are available which allow input impedance or far-field patterns to be calculated. Results for some simple antenna geometries will be presented. DOE

**N87-27092#** Lawrence Livermore National Lab., Calif.
**TEST OF A COAXIAL-LINE SOURCE MODEL FOR NEC**
G. J. Burke Mar. 1987 10 p Presented at the 3rd Annual Review of Progress in Applied Computational Electromagnetics, Monterey, Calif., 24 Mar. 1987
(Contract W-7405-eng-48)
(DE87-008488; UCRL-96440; CONF-8703109-1) Avail: NTIS HC A02/MF A01

A coaxial-line source model for wire antennas, employing a magnetic frill current, has been demonstrated in a method-of-moments solution similar to that in the computer code NEC. The solution makes use of polynomial current expansion and point matching of the field, while NEC has a spline current expansion of sin(ks), cos(ks), and constant terms with point matching. Excellent agreement between computed and measured input admittances was obtained. The coaxial-line model has been tested in NEC and results for this and the other NEC source models are compared in this paper. DOE

**N87-27093#** Oak Ridge National Lab., Tenn.
**MODELING OF COMPACT LOOP ANTENNAS**
F. W. Baity 1987 5 p Presented at the 7th Topical Conference on Applications of Radio-Frequency Power to Plasmas, Kissimmee, Fla., 4 May 1987
(Contract DE-AC05-84OR-21400)
(DE87-009507; CONF-870570-4) Avail: NTIS HC A02

A general compact loop antenna model which treats all elements of the antenna as lossy transmission lines has been developed. In addition to capacitively-tuned resonant double loop (RDL) antennas the model treats stub-tuned resonant double loop antennas. Calculations using the model have been compared with measurements on full-scale mockups of resonant double loop antennas for ATF and TFTR in order to refine the transmission line parameters. Results from the model are presented for RDL

antenna designs for ATF, TFTR, Tore Supra, and for the Compact Ignition Tokamak (CIT). DOE

**N87-27094#** Lawrence Livermore National Lab., Calif.
**ELECTROMAGNETIC SUSCEPTIBILITY TESTING OF ELECTRONIC SUBSYSTEMS BY DIRECT INJECTION**
R. J. King May 1987 16 p
(Contract W-7405-eng-48)
(DE87-009982; UCID-21061) Avail: NTIS HC A02/MF A01

A proposed direct injection technique for testing the electromagnetic susceptibility of electronic subsystems is outlined. This technique accounts for the highly complex structure of the threat signal appearing at the terminals of the subsystem, and permits the susceptibility level to be precisely and continuously measured over a wide frequency spectrum. It takes advantage of the high precision attainable from modern frequency domain instruments, as well as time domain pulsing to account for heat build-up within susceptible electronic components. The technique uses linear coupling measurements made at the cable terminals which feed the subsystem. It, therefore, includes the effects of the external threat parameters, e.g., spectral intensity of frequency components, polarization, and incidence direction. Besides being useful for establishing electronic breakdown thresholds, the technique can be used for full system analysis to verify that the electronics can survive a real threat. DOE

**N87-27095#** Uppsala Ionospheric Observatory (Sweden).
**ANALYTIC DESCRIPTION OF THE ELECTROMAGNETIC WAVE FIELD FOR EFFECTIVE REFRACTIVE INDICES WITH AN INFINITY**
Bengt Lundborg Feb. 1987 37 p Submitted for publication
(UIO-SR-87-04; ISSN-0349-2699; ETN-87-90082) Avail: NTIS HC A03/MF A01

Formulas describing the wave pattern in the linear regime of an electromagnetic wave impinging vertically upon a horizontally stratified ionosphere, where the effective refractive index squared has an infinity, a first order pole, are derived within a uniform approximation employed in wave propagation problems. The formulas are also valid at the reflection and transition points of the problem. Monotonically increasing electron density with height in the relevant region of the ionosphere is treated. Applications of the formulas derived are the X mode wave when the wave frequency is higher than the electron gyrofrequency and the O mode wave when the wave frequency is lower than the electron gyrofrequency. ESA

**N87-27096*#** Ohio State Univ., Columbus. ElectroScience Lab.
**AIRBORNE ANTENNA RADIATION PATTERN CODE USER'S MANUAL**
Walter D. Burnside, Jacob J. Kim, Brett Grandchamp, Roberto G. Rojas, and Philip Law Sep. 1985 261 p
(Grant NsG-1498)
(NASA-CR-181249; NAS 1.26:181249; Rept-716199-4) Avail: NTIS HC A12/MF A01 CSCL 20N

The use of a newly developed computer code to analyze the radiation patterns of antennas mounted on a ellipsoid and in the presence of a set of finite flat plates is described. It is shown how the code allows the user to simulate a wide variety of complex electromagnetic radiation problems using the ellipsoid/plates model. The code has the capacity of calculating radiation patterns around an arbitrary conical cut specified by the user. The organization of the code, definition of input and output data, and numerous practical examples are also presented. The analysis is based on the Uniform Geometrical Theory of Diffraction (UTD), and most of the computed patterns are compared with experimental results to show the accuracy of this solution. Author

**N87-27097*#** Ohio State Univ., Columbus. ElectroScience Lab.
**A GTD ANALYSIS OF OGIVE PEDESTAL**
Kin-Yue Albert Lai and Walter D. Burnside Mar. 1987 233 p
(Grant NsG-1613)
(NASA-CR-181269; NAS 1.26:181269; Rept-716148-8) Avail: NTIS HC A11/MF A01 CSCL 20N

The metal ogive pedestal is claimed to have low radar cross section and low observability features. This study uses the Geometric Theory of Diffraction (GTD) to analyze the pedestal scattering for three cases: direct backscattered field, backscattered field structure, and target/pedestal multiple scattering. This study can be used to evaluate the various ways that the metal conical ogive pedestal can effect the performance of a high quality radar cross section measurement system. Author

**N87-26955#** Deutsche Forschungs- und Versuchsanstalt fuer Luft- und Raumfahrt, Oberpfaffenhofen (West Germany). Inst. fuer Hochfrequenztechnik.
**THE CURRENT AND FIELD DISTRIBUTION OF A HIGH POWER SATELLITE ANTENNA AFFECTED BY NONLINEAR PLASMA SHEATH PHENOMENA**
K.-H. Bethke and P. Edenhofer (Bochum Univ., West Germany ) *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 10 p Sponsored in part by Bundesministerium fuer Forschung und Technologie, West Germany (For primary document see N87-26937 21-18)
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# 33 ELECTRONICS AND ELECTRICAL ENGINEERING

Includes test equipment and maintainability; components, e.g., tunnel diodes and transistors; microminiaturization; and integrated circuitry.

For related information see also *60 Computer Operations and Hardware* and *76 Solid-State Physics.*

**N87-27098*#** Old Dominion Univ., Norfolk, Va. Dept. of Electrical and Computer Engineering.
**A STUDY OF PULSE SURFACE FLASHOVER IN A VACUUM Final Report, 16 May 1985 - 16 May 1986**
Vishnukumar K. Lakdawala Nov. 1986 10 p
(Grant NAG1-476)
(NASA-CR-180291; NAS 1.26:180291) Avail: NTIS HC A02/MF A01 CSCL 09C

The prebreakdown phenomenon of pulsed surface flashover across solid insulators has been observed in a vacuum using image converter photography. A very good time and space resolution has been obtained. In summary, it was found that visible light (low luminosity) is initially emitted from the cathode and the light front propagates at a constant speed of approximately 1 X 10 to the 7th power ms. This low luminous light has a banded structure corresponding to the electron hopping distance as proposed in theoretical flashover models, and the light intensity gradually increases as it travels towards the anode. The bright light starts from the anode and expands towards the cathode, bridging the gap within 0.5 ns. Author

**N87-27099*#** Wittenberg Univ., Springfield, Ohio. Dept. of Physics.
**RADIATION EFFECTS ON POWER TRANSISTOR PERFORMANCE Final Report, Apr. - Jun. 1987**
Albert J. Frasca Jun. 1987 26 p
(Grant NAG3-793)
(NASA-CR-181188; NAS 1.26:181188) Avail: NTIS HC A03/MF A01 CSCL 09A

The D60T, D62T, and D75T transistors in the nuclear reactor were irradiated with bias voltage and high current I sub c vs. V sub ec curves were obtained to evaluate gain degradation at high power levels. Pre- and post-irradiation high current switching tests were performed to evaluate the response. The gamma ray damage work done at Sandia was correlated with the neutron work done at the O.S.U. reactor with the above specified transistors. Theoretical analyses of damage and electrical performance were conducted in terms of semiconductor physics. The experimental high current pulser was improved in order to measure switching

time changes which are less than one microsecond at currents of 100 to 200 amperes for in-situ testing. B.G.

**N87-27100#** Sandia National Labs., Albuquerque, N. Mex.
**RADIATION-TOLERANT, SIDEWALL-HARDENED SOI/MOS TRANSISTORS**
S. S. Tsao, D. M. Fleetwood, H. T. Weaver, L. Pfeiffer, and G. K. Celler (Bell Telephone Labs., Inc., Murray Hill, N. J.) 1987 5 p Presented at the 24th Annual Conference on Nuclear and Space Radiation in Electronics, Snowmass, Colo., 28 Jul. 1987
(Contract DE-AC04-76DP-00789)
(DE87-006716; SAND-87-0220C; CONF-870724-13) Avail: NTIS HC A02

The effects of total-dose radiation have been investigated for sidewall-hardened n-channel MOS transistors fabricated in zone-melt recrystallized (ZMR) and oxygen-implanted SOI films. Subthreshold leakage currents and threshold voltage shifts remained acceptably low for the superior ZMR devices at doses greater than 1 Mrad (SiO2). DOE

**N87-27101#** EIC, Inc., Norwood, Mass.
**DEVELOPMENT OF A NICKEL OXIDE/HYDROGEN MULTILAYER BIPOLAR BATTERY FOR PULSED POWER**
R. D. Rauh and Gerhard L. Holleck Apr. 1987 3 p
(Contract N00014-86-C-0803)
(AD-A181004) Avail: NTIS HC A02/MF A01 CSCL 10C

Spaced-based missile defense systems will require sources of pulsed power to operate prospective directed energy weapons. In principle, an electrochemical power source can provide this power at a much lower weight than alternative magnetic or electric field devices (capacitors or inductors). However, advances must be made in high rate thin film electrode materials and in battery design. In the present program we are investigating electrochemical capacities under pulsed conditions for two promising materials (1) LaNi5 which acts as hydrogen storage anode with high hydrogen diffusion rates and (2) a hydrated nickel oxide cathode with optimized mixed ionic and electronic conductivity. Thin films were prepared by reactive sputtering, vapor desposition, anodization of nickel and electrochemical precipitaiton of nickel hydroxide. GRA

**N87-27102#** Advanced Battery Group, Lancaster, N.Y.
**SAFETY CHARACTERISTICS OF LITHIUM PRIMARY AND SECONDARY BATTERY SYSTEMS. FORMULATION OF A LITHIUM BATTERY SAFETY MATRIX Final Report, Oct. 1984 - Jul. 1986**
R. F. Bis, James A. Barnes, William V. Zajac, Patrick B. Davis, and Robert M. Murphy Jul. 1986 149 p
(Contract N60921-84-C-0207)
(AD-A181040; NSWC-TR-86-296) Avail: NTIS HC A07/MF A01 CSCL 10C

A study was conducted to assess the safety characteristics for both primary and secondary lithium electrochemical systems. Of particular interest is the behavior of specific cell designs of these systems when subjected to the electrical and thermal abuse test procedures prescribed in NAVSEANOTE 9310. These abusive tests include short circuit, forced overdischarge, charge, and incineration. The main intent of the report is the formulation of a lithium battery safety matrix wherein certain electrochemical system, cell designs, or cell types which have exhibited exceptionally safe characteristics under abusive conditions may be exempt from some or all of the NAVSEANOTE 9310 test procedures. GRA

**N87-27103#** Westinghouse Electric Corp., Hunt Valley, Md. Integrated Logistics Support Div.
**THE IMPACT OF VHSIC (VERY HIGH SPEED INTEGRATED CIRCUIT) TECHNOLOGY ON AUTOMATIC TEST SYSTEMS Final Report, 22 Sep. 1986 - 30 Apr. 1987**
Joseph G. Henderson 30 Apr. 1987 156 p
(Contract F33615-86-C-5079)
(AD-A181051; AFBRMC-87-5079-I) Avail: NTIS HC A08/MF A01 CSCL 09A

The primary output of this study contract as defined by the sponsoring organization is to determine a generic VHSIC ATS architecture for VHSIC-based Line Replaceable Modules (LRMs). This was accomplished by a systematic evaluation of all known factors impacting architecture considerations. A recommended architecture was formulated by combining VHSIC-based LRM characteristics (technology implementation, performance parameters and imposed standards) with ATS requirements (technology/test methods and test equipment standards). The VHSIC-based LRM survey, conducted as part of the contract workscope, has currently yielded data on a population of 29 LRM's. The survey information has been entered and compiled in the VHSIC ATS Knowledge Base. Querying the Knowledge using selected sort criteria (Appendix E) indicates a wide variety of implementations in both circuit complexity (MSI through VLSI) and processes (bipolar, CMOS, GaAS, etc.) to achieve LRM functions (VHSIC and non-VHSIC). GRA

**N87-27104#** SRI International Corp., Menlo Park, Calif.
**PHOTON-ENHANCED ELECTRON ATTACHMENT PROCESSES IN DISCHARGE-OPENING SWITCHES Final Report, 15 Aug. 1983 - 30 Jun. 1987**
Michel J. Rossi, Hanspeter Helm, and Donald C. Lorents Feb. 1987 145 p
(Contract DAAG29-83-K-0113)
(AD-A181055; ARO-19934.5-PH) Avail: NTIS HC A07/MF A01 CSCL 07D

Electron attachment data for dissociative electron attachment are reported for several species in the ground electronic state as well as after laser excitation. The experimental apparatus used consisted in a Gruenberg type drift cell fitted with windows for cathode illumination and laser excitation of a volume oriented parallel to the electrodes forming the gap. The time dependent electron swarm population was monitored as a transient voltage as a function of various swarm parameters and laser irradiation conditions. GRA

**N87-27105#** Utah Univ., Salt Lake City. Dept. of Electrical Engineering.
**THEORETICAL DESIGN STUDY OF A 2-18 GHz BANDWIDTH HELIX TWT (TRAVELING WAVE TUBE) AMPLIFIER Final Report, Sep. 1982 - Oct. 1986**
Michael A. Frisoni Feb. 1987 101 p
(Contract F30602-82-C-0161)
(AD-A181108; UTEC-MD-86-059; RADC-TR-87-22) Avail: NTIS HC A06/MF A01 CSCL 09A

This report investigates the concept of applying an extremely dispersive helix section prior to a nondispersive helix section in a traveling wave tube (TWT) output circuit in order to realize a 2 to 18 GHz frequency bandwidth. The nondispersive helix circuit provides the synchronism for multioctave performance, and the dispersive helix circuit yields the second harmonic relative phase shift necessary for harmonic suppression at the low frequency band edge. Fundamental efficiency enhancement and harmonic power content are shown to be a function of the circuit phase velocity characteristics, the injection velocity parameter, and circuit length. Also described is the effect of the Crestatron interaction phenomena on the TWT's performance. All the results are based on one-dimensional large signal computer calculations. GRA

**N87-27106#** Utah Univ., Salt Lake City. Dept. of Electrical Engineering.
**A LARGE-SIGNAL ANALYSIS PROGRAM FOR HELIX TRAVELING-WAVE TUBES Final Report, Sep. 1982 - Oct. 1986**
Theresa A. Brunasso Feb. 1987 91 p
(Contract F30602-82-C-0161)
(AD-A181111; UTEC-MD-86-063; RADC-TR-87-25) Avail: NTIS HC A05/MF A01 CSCL 09A

A one-dimensional large-signal analysis computer code for Helix traveling-wave tubes was developed. The program was written in FORTRAN 77 and implemented on an HP-1000 computer at Teledyne MEC in Palo Alto, Calif. The program is well documented

and can accommodate attenuators, severs, velocity changes, linear velocity tapers, and multiple input signals. Two Teledyne MEC tubes were simulated with the program and the results were in very good agreement with experimental data. Large-signal analysis programs are widely used by the microwave tube community to predict the performance of helix traveling-wave tubes. These nonlinear programs allow an engineer to optimize a tube design without building several prototype tubes. Unfortunately, currently available programs are complex and poorly documented. The purpose of this project is to provide a structured, well documented large-signal analysis program to the scientific and industrial community. GRA

**N87-27107#** Scientific Research Associates, Inc., Glastonbury, Conn.
**NUMERICAL SIMULATION OF THE PERMEABLE BASE TRANSISTOR Final Report, 1 Sep. 1984 - 31 Dec. 1986**
M. Meyyanppan, J. P. Kreskovsky, B. Morrison, and H. L. Grubin
4 May 1987 151 p
(Contract F49620-84-C-0106)
(AD-A181182; SRA-R-910010-F; AFOSR-87-0689TR) Avail: NTIS HC A08/MF A01 CSCL 09A

This document describes the results of an SBIR Phase 2 program to investigate, through numerical simulation, the operational physics of the gallium arsenide permeable base transistor. Two distinct algorithms were used in the study: the semiconductor drift and diffusion equation algorithm and the moments of the Boltzmann transport equation algorithm. The results of the study show that one-micron feature size PBTs are capable of: (1) cutoff frequencies in excess of 120 GHz, (2) fmax values in the vicinity of 200 GHz, and (3) breakdown voltages in excess of 17 volts. The study also demonstrates that the design of the PBT is compatible with hydrodynamic flow concepts, which suggest means to significantly reduce the capacitance of the PBT. GRA

**N87-27108#** Purdue Univ., West Lafayette, Ind. School of Electrical Engineering.
**INVESTIGATION OF A NEW CONCEPT IN SEMICONDUCTOR MICROWAVE OSCILLATORS Annual Report, 1 May 1986 - 22 May 1987**
James A. Cooper, Jr. 31 May 1987 25 p
(Grant AF-AFOSR-0193-85)
(AD-A181219; AFOSR-87-0779TR) Avail: NTIS HC A02/MF A01 CSCL 09A

The goal of this project is to demonstrate the operation of a new millimeter wave source called a contiguous. This device uses the transferred electron effect in GaAs to form contiguous charge domains in the channel of a resistive gate MESFET or MODFET. The resulting drain current exhibits microwave oscillations in the range from a few GHz to a few hundred GHz. The oscillation is not based on a transit time effect, and as a result the frequency can be tuned over a broad band during operation by adjusting the gate-to-source voltage. During the past year we fabricated eight wafers of MESFET-type oscillator devices. Of the six wafers that reached the end of the process, four produced devices which were functional at DC test. The most recent wafer contained thirty six working devices. We have acquired equipment to conduct microwave measurements up to 90 GHz, which should be satisfactory for initial testing. During the next few months we expect to perform the microwave characterization which will verify the contiguous domain concept. GRA

**N87-27109#** Boeing Aerospace Co., Seattle, Wash.
**HIGH VOLTAGE PULSE TEST PLAN Final Report, 31 Mar. - 15 Dec. 1986**
William G. Dunbar Apr. 1987 38 p
(Contract F33615-81-C-2013)
(AD-A181242; AFWAL-TR-87-2005) Avail: NTIS HC A03/MF A01 CSCL 20C

The purpose of this program is to prepare a high voltage pulse test plan for three types of test articles to interrelate the findings of the High Voltage Pulse Survey and High Voltage Testing: Volume 1, Test Program Report, and Volume 2, Specifications and Test Procedures, AFWAL-TR-82-2057. This test plan will be developed from the baseline of test procedures established in Volume 2 which utilize a 1.2 X 50 microsecond waveform. The test plan will detail other pulse waveform parameters, voltage magnitudes, and number of pulses required to evaluate the component under test in conjunction with the results of the Pulse Test Survey already completed (AFWAL-TR-85-2079). GRA

**N87-27110#** Booz-Allen and Hamilton, Inc., Bethesda, Md.
**NETWORK LEVEL EMP EFFECTS SENSITIVITY STUDY ON SELECTED TELECOMMUNICATIONS EQUIPMENT Final Report**
27 Mar. 1987 78 p Sponsored by National Communications System
(AD-A181404; NCS-TIB-87-11) Avail: NTIS HC A05/MF A01 CSCL 09C

The EMP Mitigation Program uses a network level approach to assess EMP effects on network performance. The approach is twofold. First, the effects of EMP on network equipment are obtained. The OMNCS has made EMP test program results available on the 1ESS and 5ESS switches; the TD-2 microwave, L4 carrier, T1 Carrier, and FT3C fiber optic transmission systems; and the D4 channel bank. Second, the performance of the network exposed to EMP is characterized. This is accomplished by combining the equipment test program results with the network topology. A computer model, predicated on a statistical interpretation of EMP test data, processes this information and calculates a metric to characterize network performance. The model is run multiple times in a Monte Carlo process to calculate probabilistically the point-pair connectivity metric. Point-pair connectivity is a measure of the surviving connections with respect to the original connections. In estimating network performance the model acknowledges fundamental uncertainties in the supporting input data. GRA

**N87-27111#** Army Cold Regions Research and Engineering Lab., Hanover, N. H.
**ELECTRICAL GROUNDING IN COLD REGIONS Technical Digest**
Karen Henry Mar. 1987 19 p
(AD-A181405; CRREL-TD-87-1) Avail: NTIS HC A02/MF A01 CSCL 20C

Electrical grounding for temporary and permanent installations in cold regions is complicated by the existence of frozen soil. This is because the electrical resistivity of frozen soil can be several orders of magnitude higher than unfrozen soil, the contact resistance between the grounding electrodes and the soil, which is usually negligible under unfrozen conditions, can become significant if a veneer of ice forms on the electrode, and it is difficult to drive grounding rods into frozen soil. The purpose of this digest is to describe the factors to consider when planning a grounding system for permanent and temporary installations in regions of seasonal frost and permafrost. GRA

**N87-27112#** Energy Research Corp., Danbury, Conn.
**PRE-PROTOTYPE 5 kW FUEL CELL POWER PLANT DEVELOPMENT Final Report, 20 May 1982 - 30 Jan. 1986**
Sandors Abens and Mohammad Farooque Apr. 1987 41 p
(Contract F33615-82-C-2201)
(AD-A181545; AFWAL-TR-86-2115) Avail: NTIS HC A03/MF A01 CSCL 10C

A five kilowatt Phosphoric Acid Fuel Cell (PAFC) power plant, with the ability to operate on neat methanol, was developed and tested. Overall thermal efficiency at full load (based on the lower heating value of methanol) was 32 percent. GRA

**N87-27113#** California Univ., Santa Barbara. Dept. of Electrical and Computer Engineering.
**USE OF DEPLETION-EDGE-TRANSLATION FOR HIGH SPEED MODULATION AND SWITCHING OF LIGHTWAVES Interim Report, Aug. 1986 - Feb. 1987**
Larry A. Coldren, J. G. Mendoza-Alvarez, T. C. Huang, T. R. Hausken, and K. W. Lee 22 May 1987 20 p

(Grant AF-AFOSR-0323-85)
(AD-A181629; CU-ECE-87-04; AFOSR-87-0775TR) Avail: NTIS HC A02/MF A01 CSCL 20F

This report focused on the investigation of the basic properties of novel depletion edge translation (DET) waveguide phase modulators oriented in the plane of the substrate. Devices based upon this concept have now provided record levels of phase shifting efficiency, and theoretical calculations have indicated a significant potential for still further improvements in this area. The in plane geometry maximizes the interaction between applied fields and the propagating wave by maximizing the optical energy density, the applied fields and providing the necessary interaction length. In this report we review the progress in three separate areas: (1) theory and design of DET devices; (2) improvements in fabrication technology; and (3) experimental device measurements. GRA

**N87-27114#** Lawrence Livermore National Lab., Calif.
**MICROWAVE COMPONENT SUSCEPTIBILITY, FY86 Final Report**
C. McConaghy Nov. 1986 27 p
(Contract W-7405-eng-48)
(DE87-003601; UCID-20923) Avail: NTIS HC A03/MF A01

The work in component susceptibility for FY86 was concentrated in three areas: radar front end components, dielectric coated laser mirrors, and computer code validation experiments. This is also the rough chronological order of the work throughout the fiscal year. In this report, each of the areas will be addressed in terms of objectives and results. The computer validation experiments are still ongoing and will continue through FY87. DOE

**N87-27115#** Oak Ridge National Lab., Tenn.
**GAS ENGINEERING FOR PULSED POWER AND SWITCHING**
S. R. Hunter May 1987 10 p Presented at the 5th International Symposium on Gaseous Dielectrics, Knoxville, Tenn., 3 May 1987
(Contract DE-AC05-84OR-21400)
(DE87-008825; CONF-870516-6) Avail: NTIS HC A02

Studies of externally sustained diffuse gas discharge switches have demonstrated that diffuse discharges possess the potential for fast, repetitive, high power switching in inductive energy storage pulsed power applications. Several analyses have determined the operating requirements on the diffuse discharge in these applications and have shown the importance of gas engineering by tailoring the properties of the gas mixture within the switch to achieve the desired operating conditions. More recently, attention has been turned to ways of improving the current switching efficiency of these discharges (i.e., lower discharge impedance operation) and to the development of techniques to actively control the switch opening and closing by optically modifying the electron attachment and detachment processes in the discharge gas mixture. These and other possible research areas in gas engineering studies for pulsed power switches are discussed. DOE

**N87-27116#** California Univ., Berkeley.
**HIGH TEMPERATURE STABILITY OF W/GaAs SCHOTTKY CONTACTS: STRUCTURAL AND ELECTRICAL STUDIES Ph.D. Thesis**
S. K. Cheung Jun. 1986 88 p
(Contract DE-AC03-76SF-00098)
(DE87-009178; LBL-22711) Avail: NTIS HC A05/MF A01

W/GaAs Schottky diodes were fabricated and furnace-annealed in the temperature range 100 to 900°C. The diodes were characterized by current-voltage (I-V) and capacitance-voltage (C-V) dependences, Rutherford Backscattering Spectrometry (RBS), Scanning Electron Microscopy (SEM), and Transmission Electron Microscopy (TEM). Deviations from ideal diode behavior were observed at annealing temperatures above 600°C. Interdiffusion of W and GaAs was observed at 650°C by RBS. Results strongly suggest that the electrical degradation of the diodes is correlated with the formation of a highly resistive layer near the W/GaAs interface. The high resistance of this layer may be attributed to the compensation of substrate dopants by the in-diffused W atoms. Annealing the diodes at temperatures above 850°C resulted in reactions between W and GaAs. The W-GaAs reaction led to the formation of islands of W2As3 at the W/GaAs interface resulting in physical breakdown of the W/GaAs diode. DOE

**N87-27117#** Oak Ridge National Lab., Tenn.
**MOTOR CURRENT SIGNATURE ANALYSIS FOR DETERMINING OPERATIONAL READINESS OF MOTOR-OPERATED VALVES (MOVs)**
R. C. Kryter and H. D. Haynes 1987 19 p Presented at the 4th Conference on Utility Experience in Reactor Noise Analysis, Hartford, Conn., 12 May 1987
(Contract DE-AC05-84OR-21400)
(DE87-009830; CONF-870598-1-Abst-) Avail: NTIS HC A02/MF A01

Motor current signature analysis (MCSA) is a novel diagnostic process for condition monitoring of electric-motor-driven mechanical equipment (e.g., pumps, motor-operated valves, compressors, and processing machinery). The MCSA process identifies, characterizes, and trends over time the instantaneous load variations of mechanical equipment in order to diagnose changes in the condition of the equipment (e.g., due to degradation or service wear), which, if allowed to continue, may lead to failure. It monitors the instantaneous variations (noise content) in the electric current flowing through the power leads to the electric motor that drives the equipment. The motor itself thereby acts as a transducer, sensing both large and small, long-term and rapid, mechanical load variations and converting them to variations in the induced current generated in the motor windings. This motor current noise signature is detected, amplified, and further processed as needed to examine its time domain and frequency domain (spectral) characteristics. The operational principles of MCSA and the nonintrusive data collection apparatus and procedure used with MOVs will be described. Data collected from MOVs in both laboratory and in-plant environments will also be shown to illustrate the ability of MCSA to see the detailed inner workings of the valve and operator and thus to detect degraded performance at an incipient stage. DOE

**N87-27118#** Michigan Univ., Ann Arbor. Transportation Research Inst.
**EVALUATION OF AN LED (LIGHT-EMITTING DIODE) HIGH-MOUNTED SIGNAL LAMP**
P. L. Olson Feb. 1987 42 p Sponsored by Stanley Electric Co. Ltd., Tokyo, Japan
(PB87-188025; UMTRI-87-13) Avail: NTIS HC A03/MF A01 CSCL 09A

Two studies are described evaluating high-mounted stoplights using light-emitting diodes (LEDs) compared with conventional incandescent units. The first of these studies obtained ratings from subjects who drove one car and followed another car that was equipped with the test lamps. The results indicate that the subjects generally preferred the LEDs to the conventional lamp. The second study was a laboratory evaluation of the attention-getting capabilities of LED and incandescent stoplights. Under all conditions tested subjects responded faster to the LED units. The response time advantage for the LED units increased with more difficult viewing conditions, such as high levels of illumination and long viewing distance. The results of these investigations are discussed in terms of the applicability of the LED technology to high mounted stoplights on motor vehicles. GRA

**N87-27119*#** Texas A&M Univ., College Station. Dept. of Chemical Engineering.
**OPTIMIZATION OF THE LITHIUM/THIONYL CHLORIDE BATTERY Final Report, 1 Sep. 1986 - 31 Aug. 1987**
Ralph E. White Aug. 1987 12 p
(Grant NAG9-177)
(NASA-CR-181224; NAS 1.26:181224) Avail: NTIS HC A02/MF A01 CSCL 10C

The progress which has been made in modeling the lithium/thionyl chloride cell over the past year and proposed research for the coming year are discussed. A one-dimensional mathematical model for a lithium/thionyl chloride cell has been

developed and used to investigate methods of improving cell performance. During the course of the work a problem was detected with the banded solver being used. It was replaced with one more reliable. Future work may take one of two directions. The one-dimensional model could be augmented to include additional features and to investigate in more detail the cell temperature behavior, or a simplified two-dimensional model for the spirally wound design of this battery could be developed to investigate the heat flow within the cell. Author

**N87-27120*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**AN EXPERIMENTAL INVESTIGATION OF PARASITIC MICROSTRIP ARRAYS**
Richard Q. Lee, Roberto Acosta, J. S. Dahele, and K. F. Lee (Akron Univ., Ohio.) Sep. 1987 15 p Prepared for presentation at the Symposium on Antenna Application, Monticello, Ill., 23-25 Sep. 1987; sponsored in part by Illinois Univ. and Rome Air Development Center
(NASA-TM-100168; E-3731; NAS 1.15:100168) Avail: NTIS HC A02/MF A01 CSCL 09C

The characteristics of a parasitic microstrip antenna array with a center-fed patch are experimentally investigated. The parasitic array is composed of identical parasitic patches which are symmetrically arranged and electromagnetically coupled to a center-fed patch. The shape and dimensions of the parasitic patches and their positions relative to the center-fed patch are parameters in the study. To show mutual coupling effects between radiating and nonradiating edges of adjacent patches, the impedance and radiation characteristics of a three-element parasitic array excited with (0.1) mode are examined, and compared to that of a single patch. Experimental data indicate that the presence of parasitic patches has significant effects upon the gain, resonant frequency, and impedance bandwidth of the array. Author

**N87-27121*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**DIFFUSION LENGTH MEASUREMENTS IN BULK AND EPITAXIALLY GROWN 3-5 SEMICONDUCTORS USING CHARGE COLLECTION MICROSCOPY**
R. P. Leon May 1987 9 p Presented at the 19th Photovoltaic Specialists Conference, New Orleans, La., 4-8 May 1987; sponsored by IEEE
(NASA-TM-100128; E-3677; NAS 1.15:100128) Avail: NTIS HC A02/MF A01 CSCL 20L

Diffusion lengths and surface recombination velocities were measured in GaAs diodes and InP finished solar cells. The basic techniques used was charge collection microscopy also known as electron beam induced current (EBIC). The normalized currents and distances from the pn junction were read directly from the calibrated curves obtained while using the line scan mode in an SEM. These values were then equated to integral and infinite series expressions resulting from the solution of the diffusion equation with both extended generation and point generation functions. This expands previous work by examining both thin and thick samples. The surface recombination velocity was either treated as an unknown in a system of two equations, or measured directly using low e(-) beam accelerating voltages. These techniques give accurate results by accounting for the effects of surface recombination and the finite size of the generation volume. Author

**N87-27122#** Sheffield Univ. (England). Dept. of Control Engineering.
**THE MODELING AND CONTROL OF AC ELECTRIC WINDERS**
R. Zhao and J. B. Edwards Oct. 1986 22 p Submitted for publication
(RR-300; ETN-87-90097) Avail: NTIS HC A02/MF A01

A set of mathematical equations for a typical electric winder system was established. The closed loop control system of the electric winder was modeled using a digital computer. Its operation is simple, requiring only one variable, the payload, to be input yet the operational results for the entire control system are satisfactory. ESA

**N87-26954#** ERA Ltd., Leatherhead (England). Applied Physics Dept.
**RADIATION CHARGING AND BREAKDOWN OF INSULATORS**
D. K. Davies *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 7 p (For primary document see N87-26937 21-18)
Copyright Avail: NTIS HC A13/MF A01

**N87-26959#** Atomic Energy Research Establishment, Harwell (England).
**SURFACE MODIFICATION TO MINIMISE THE ELECTROSTATIC CHARGING OF KAPTON IN THE SPACE ENVIRONMENT**
D. Verdin and M. J. Duck *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 12 p Sponsored in part by the Royal Aircraft Establishment, Farnborough, England (For primary document see N87-26937 21-18)
Copyright Avail: NTIS HC A13/MF A01

# 34 FLUID MECHANICS AND HEAT TRANSFER

Includes boundary layers; hydrodynamics; fluidics; mass transfer; and ablation cooling.

For related information see also *02 Aerodynamics* and *77 Thermodynamics and Statistical Physics.*

**N87-27123*#** North Carolina Univ.,. Raleigh. Dept. of Mechanical and Aerospace Engineering.
**VISCOUS FLOW DRAG REDUCTION BY ACOUSTIC EXCITATION Final Report**
Robert T. Nagel 2 Dec. 1986 27 p
(Grant NAG1-424)
(NASA-CR-180298; NAS 1.26:180298) Avail: NTIS HC A03/MF A01 CSCL 20D

An experimental program in which the effectiveness of a single large eddy break up (LEBU) blade is enhanced by proper acoustic excitation is described. Acoustic waves are generated in response to the incident large scale eddies and directed at the blade trailing edge through the test surface floor below the manipulator blade. The acoustic input is phase locked to the incident flow. Control of the acoustic input apparently allows enhancement of the large eddy cancellation process leading to a decrease of skin friction coefficient. Control of this process with acoustic excitation indicates that vortex unwinding is the mechanism for large eddy destruction in the boundary layer. A deeper understanding of this phenomena could lead to better drag reduction technology and further understanding of the physics of the turbulent boundary layer. Author

**N87-27124*#** Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Aerospace Engineering.
**AN EXPERIMENTAL STUDY OF THE PROPERTIES OF SURFACE PRESSURE FLUCTUATIONS FOR SEPARATING TURBULENT BOUNDARY LAYERS Final Report, 15 Mar. 1984 - 15 Sep. 1986**
Roger L. Simpson 12 Nov. 1986 11 p
(Grant NAG1-446)
(NASA-CR-180295; NAS 1.26:180295) Avail: NTIS HC A02/MF A01 CSCL 20D

Noise generated by helicopter and turbomachine rotors is a nuisance that designers would like to predict and to minimize within other design constraints. A key element for the noise calculation procedure is knowledge relating the flowfield structure to the surface pressure fluctuation structure. Surface pressure fluctuation data for zero-pressure-gradient and accelerating turbulent boundary layers were obtained. The zero-pressure-gradient

turbulent boundary layers were examined with freestream velocities of 72 and 105 fps. Mean and fluctuation velocity profiles and streamwise velocity spectra and wavespeeds were obtained for mementum thickness Reynolds numbers up to 18000 for the zero-pressure-gradient case and up to 4000 for the favorable-pressure-gradient case. The wall shearing stress was estimated from a Clauser plot of the near wall data. It is clear that turbulent pressure fluctuations are produced by turbulent velocity fluctuation. Detailed simultaneous measurements of all of these fluctuations are needed to determine in more detail the structural relationships between velocity and pressure fields. Although some measurements were made for unseparated flows, none were made for separated flows. B.G.

**N87-27125*#** Pennsylvania State Univ., University Park. Dept. of Aerospace Engineering.
**REYNOLDS STRESS CLOSURE IN JET FLOWS USING WAVE MODELS Semiannual Status Report**
P. J. Morris 27 Oct. 1986 12 p
(Grant NAG1-657)
(NASA-CR-180302; NAS 1.26:180302) Avail: NTIS HC A02/MF A01 CSCL 20D

A wave model was developed for the two dimensional shear layer. This configuration is being used as a test case for the closure schemes. Numerical methods are under development to solve the nonseparable Rayleigh equation. A model problem is being used to assist in the algorithm development. An analytic solution of the Rayleigh equation for a basic elliptic flow was obtained. This will be used to verify the stability codes developed for arbitrary geometries. Other numerical methods for solving the Rayleigh equation based on the boundary element technique are being examined. Author

**N87-27126*#** Old Dominion Univ., Norfolk, Va. Dept. of Mechanical Engineering and Mechanics.
**COUPLED FLOW, THERMAL AND STRUCTURAL ANALYSIS OF AERODYNAMICALLY HEATED PANELS Progress Report, period ending 31 Dec. 1986**
Earl A. Thornton and Pramote Dechaumphai Mar. 1986 10 p
(Grant NsG-1321)
(NASA-CR-180687; NAS 1.26:180687) Avail: NTIS HC A02/MF A01 CSCL 20D

A finite element approach to coupling flow, thermal and structural analyses of aerodynamically heated panels is presented. The Navier-Stokes equations for laminar compressible flow are solved together with the energy equation and quasi-static structural equations of the panel. Interactions between the flow, panel heat transfer and deformations are studied for thin stainless steel panels aerodynamically heated by Mach 6.6 flow. Author

**N87-27127*#** North Carolina State Univ., Raleigh. Dept. of Mechanical and Aerospace Engineering.
**ENHANCED VISCOUS FLOW DRAG REDUCTION USING ACOUSTIC EXCITATION Semiannual Progress Report, period ending 14 Sep. 1986**
Robert T. Nagel 20 Jan. 1987 21 p
(Grant NAG1-654)
(NASA-CR-180692; NAS 1.26:180692) Avail: NTIS HC A02/MF A01 CSCL 20D

Proper acoustic excitation of a single large-eddy break-up device can increase the resulting drag reduction and, after approximately 40 to 50 delta downstream, provide net drag reduction. Precise optimization of the input time delay, amplitude and response threshold is difficult but possible to achieve. Drag reduction is improved with optimized conditions. The possibility of optimized processing strongly suggests a mechanism which involves interaction of the acoustic waves and large eddies at the trailing edge of the large eddy break-up device. Although the mechanism for spreading of this phenomenon is unknown, it is apparent that the drag reduction effect does tend to spread spanwise as the flow convects downstream. The phenomenon is not unique to a particular blade configuration or flow velocity, although all data have been obtained at relatively low Reynolds numbers. The general repeatibility of the results for small configuration changes serves as verification of the phenomenon. Author

**N87-27128*#** Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.
**RESEARCH IN COMPUTATIONAL FLUID DYNAMICS Semiannual Progress Report, 1 Sep. 1986 - 28 Feb. 1987**
Earll M. Murman 27 Apr. 1987 32 p
(Grant NAG1-507)
(NASA-CR-180542; NAS 1.26:180542; MIT-OSP-95315) Avail: NTIS HC A03/MF A01 CSCL 20D

The numerical integration of quasi-one-dimensional unsteady flow problems which involve finite rate chemistry are discussed, and are expressed in terms of conservative form Euler and species conservation equations. Hypersonic viscous calculations for delta wing geometries is also examined. The conical Navier-Stokes equations model was selected in order to investigate the effects of viscous-inviscid interations. The more complete three-dimensional model is beyond the available computing resources. The flux vector splitting method with van Leer's MUSCL differencing is being used. Preliminary results were computed for several conditions. B.G.

**N87-27129*#** Texas A&M Univ., College Station. Dept. of Aerospace Engineering.
**COMPUTATIONAL FLUID DYNAMICS AND AEROTHERMODYNAMICS Semiannual Progress Report, Jan. - Jun. 1987**
Leland A. Carlson Jul. 1987 38 p
(Grant NAG9-192)
(NASA-CR-181111; NAS 1.26:181111; TAMRF-5671-87-01)
Avail: NTIS HC A03/MF A01 CSCL 20D

At the present time the efforts on this project are organized into two areas: the development of an approximate stagnation point solution and approximate flowfield studies which can be used to develop and investigate shock jump, electron temperature, radiation, vibration-dissociation coupling, and chemistry models. Progress in each area is discussed. B.G.

**N87-27130*#** Massachusetts Inst. of Tech., Cambridge. Dept. of Aeronautics and Astronautics.
**COMPUTATIONAL METHODS FOR VORTEX DOMINATED COMPRESSIBLE FLOWS Final Report, 1 Apr. 1983 - 30 Jun. 1987**
Earll M. Murman 4 Aug. 1987 4 p
(Grant NAG1-358)
(NASA-CR-181144; NAS 1.26:181144; MIT-OSP-93666) Avail: NTIS HC A02/MF A01 CSCL 20D

The principal objectives were to: understand the mechanisms by which Euler equation computations model leading edge vortex flows; understand the vortical and shock wave structures that may exist for different wing shapes, angles of incidence, and Mach numbers; and compare calculations with experiments in order to ascertain the limitations and advantages of Euler equation models. The initial approach utilized the cell centered finite volume Jameson scheme. The final calculation utilized a cell vertex finite volume method on an unstructured grid. Both methods used Runge-Kutta four stage schemes for integrating the equations. The principal findings are briefly summarized. B.G.

**N87-27131#** Sandia National Labs., Albuquerque, N. Mex.
**EVALUATION OF THERMAL AND KINETIC PROPERTIES SUITABLE FOR HIGH HEATING RATE COMPUTATIONS**
I. Auerbach, D. A. Benson, and G. F. Wright, Jr. 1987 35 p
Presented at the 22nd AIAA Thermophysics Conference, Honolulu, Hi., 8 Jun. 1987
(Contract DE-AC04-76DP-00789)
(DE87-009543; SAND-86-2646C; CONF-870623-4) Avail: NTIS HC A03/MF A01

Computer codes that model dimensional, weight, and energy changes in ablative or pyrolysis materials, such as ballistic missile reentry vehicle heatshields or thermal insulators, generally have to use effective rather than measured property values for some

of their input. A primary reason for the discrepancy in values is that the properties are not measured under the heating rate and temperature conditions for which they will be used. In this study, heat capacity, thermal conductivity, and kinetic parameters from thermogravimetric analysis data are generated under the high heating rate conditions that simulate reentry and abrupt fire conditions. Differences in values between steady state or low heating rate data and high heating rate data are examined. The Charring Material Ablation program is used to model ablation material and insulator performance using high heating rate properties to show the improved correlation between computed and observed test results. DOE

**N87-27132#** Gosudarstvennyi Komitet po Ispolzovaniyu Atomnoi Energii, Obninsk (USSR). Fiziko-Ehnergeticheskij Inst.
**EMPIRICAL FORMULAE FOR VELOCITY FIELDS AND COEFFICIENTS OF MOMENTUM AND HEAT TURBULENT TRANSFER IN LINEAR CHANNELS OF INTRICATE SHAPE**
N. I. Buleev, G. A. Zinina, L. Ya. Kazakova, R. Ya. Mironovich, and M. M. Timukhina 1985 11 p In RUSSIAN
(DE87-702259; FEI-1698) Avail: NTIS (US Sales Only) HC A02/MF A01

Empirical formulas for velocity fields and coefficients of turbulent heat transfer in steady flows of liquid in rectilinear channels of complex configuration are presented. The data permit the simplification of the equation solution algorithm of heat transfer in channels with complex boundaries. The effect of interchannel mixing is taken into account in addition to turbulent heat transfer. Formulas for the velocity fields and turbulent heat transfer coefficients were tested using calculations for velocity fields and temperature of liquid steady turbulent flows in a round tube and liquid flow in annular gaps. Suggested formulas for turbulent heat transfer coefficients are widely used for numerical studies of temperature fields in non-standard cells of reactor fuel assembly. A good agreement between calculated and experimental data is obtained. DOE

**N87-27133#** Gosudarstvennyi Komitet po Ispolzovaniyu Atomnoi Energii, Obninsk (USSR). Fiziko-Ehnergeticheskij Inst.
**METHOD SOLVING HYDRODYNAMICS EQUATIONS USING VELOCITY VARIABLES**
M. P. Leonchuk, Z. V. Sivak, and Yu. E. Shvetsov 1985 15 p In Russian
(DE87-702260; FEI-1705) Avail: NTIS (US Sales Only) HC A02/MF A01

An effective numerical method for solving Navier-Stokes equations and those for porous body models in velocity variables is suggested. The nonexplicit difference analog of the solvable system of equations is obtained by its integration on the net with separated velocity and pressure components and using an approximation down the flow for convective members. To solve it numerically, a trial run method is used that is characterized by an exact solution of a continuity equation at each calculation step. The suggested method is absolutely stable, has a high convergence rate as compared to the methods in velocity-pressure variables and may be used for calculating turbulent flows and flows in the regions with heterogeneous properties. The above method is realized as DUPT program unit for BESM-6 and ES-1060 computers, and is aimed to calculate liquid flow in multi-coupled regions with varied properties, for example, in nuclear reactor coolant circuits. DOE

**N87-27134#** Wisconsin Univ., Madison. Mathematics Research Center.
**ON THE ACCURACY OF FINITE ELEMENT AND FINITE DIFFERENCE PREDICTIONS OF NON-NEWTONIAN SLOT PRESSURES FOR A MAXWELL FLUID Technical Summary Report**
David S. Malkus and Michael F. Webster Dec. 1986 35 p
(Contract DAAG29-80-C-0041; Grant AF-AFOSR-0141-85)
(AD-A180768; MCR-TSR-2960) Avail: NTIS HC A03/MF A01 CSCL 20D

Plane slow flow of a Maxwell fluid over a transverse slot is considered. Results are computed by a finite difference method (FDM) using the differential form of the constitutive equation, and by a finite element method (FEM) using the integral form. Even on fine grids, the two methods produce different results, particularly at low D sub e. However, extrapolation of the results to zero mesh spacing shows excellent agreement between the two methods. Hence both methods are convergent with mesh refinement, but high accuracy would require extremely fine meshes. An explanation is provided for why it is unreasonable to expect either method accurately to obtain the singular limit of P sub e N sub 1 as D sub e approaches limit of 0. Also an explanation for the errors at very low D sub e is offered. If we presume the second-order fluid (SOE) result holds for very low D sub e (i.e., P sub e = N sub 1/4), both the FEM and FDM predict only minor deviation from this value for the Maxwell fluid, in the range less than or = sub e less than or =. GRA

**N87-27135#** Arizona State Univ., Tempe.
**THREE DIMENSIONAL STRUCTURE OF TRANSITIONAL BOUNDARY LAYERS Annual Report, 15 Jun. 1985 - 30 Sep. 1986**
William S. Saric 1 May 1987 25 p
(Contract F49620-85-C-0089)
(AD-A181011; AFOSR-87-0739TR) Avail: NTIS HC A02/MF A01 CSCL 20D

An overview of research on the three dimensional nature of boundary layer transition conducted by the contractor and others is reviewed in this report. The report reviews the implications of three-dimensionality arising from several sources, including background and free-stream disturbances, curvature, cross flow and imposed streamwise vorticity. GRA

**N87-27136#** Wisconsin Univ., Madison. Mathematics Research Center.
**MODELING OF SHOCKLESS ACCELERATION OF THIN PLATES USING A TRACKED RANDOM CHOICE METHOD Technical Summary Report**
Bradley J. Plohr Feb. 1987 43 p
(Contract DAAG29-80-C-0041; Grant NSF DMS-86-01766)
(AD-A181012; MRC-TSR-2968) Avail: NTIS HC A03/MF A01 CSCL 20D

A method for accelerating thin metallic plates to hypervelocities has been proposed by G. McCall. In this method a shock in a propellant generates a strong expansion wave that smoothly accelerates the plate. We have studied the hydrodynamics of this process in one dimension, both analytically and computationally. The metal was modeled as a stiffened gas, and the corresponding Riemann problem was solved. The asymptotic behavior of the solution was determined analytically. The one-dimensional random choice method, modified so that material boundaries are tracked and the spatial mesh is refined locally, was used to compute the flow; comparison with the asymptotic solution demonstrated its accuracy. With this method, shocks that form within the accelerating plate were accurately resolved, so that possible structural damage to the plate could be evaluated. GRA

**N87-27137#** Stanford Univ., Calif. Thermosciences Div.
**ZONAL MODELS OF TURBULENCE AND THEIR APPLICATION TO FREE SHEAR FLOWS**
K.-L. Tzuoo, J. H. Ferziger, and S. J. Kline Nov. 1986 154 p
(Contract F49620-86-K-0008)
(AD-A181177; TF-27) Avail: NTIS HC A08/MF A01 CSCL 20D

The concept of zonal modeling is tested by using three homogeneous flows. It is found that two governing parameters suffice to classify all free shear flows considered. The first parameter represents the ratio of the inertial force to the driving force of the shear layer or, alternatively, the ratio of eddy turn-over time to the characteristic free stream time. It determines the relative importance of the diffusion process in the turbulence transport mechanism. The larger this parameter, is the more important the diffusion process of turbulence becomes. The other parameter is

a measure of lateral vortex stretching. Strong vortex stretching reduces the correlation between turbulent shear stress and turbulent kinetic energy and hence reduces the spreading rate of the flow. There are a total of three zones found in the class of free shear flows; they represent the limiting values of the two governing parameters. The zonal models for these three zones are built separately. They are then blended to allow readjustments between zones by means of readjusted parameters that are functions of the governing parameters. As a result, a unified zonal model for all free shear flows is produced. GRA

**N87-27138#** Integrated Systems, Inc., Palo Alto, Calif.
**BEHAVIOR OF A VORTICITY-INFLUENCED ASYMMETRIC STRESS TENSOR IN FLUID FLOW Final Report, 1 Jul. 1985 - 29 May 1986**
C. H. Berdahl and W. Z. Strang Oct. 1986 65 p
(AD-A181244; AFWAL-TR-87-3020) Avail: NTIS HC A04/MF A01 CSCL 20D

The Navier Stokes momentum equations describe the general movement of a Newtonian fluid. In classic derivation of these equations, an entity called the stress tensor is postulated to exist. Classic thought allowed the stress to depend on dilation and deformation but assumed no effect of vorticity on stress. Because the complete Navier Stokes equations had not yielded to numerical solution until the last few years, it has been impractical to test the validity of assuming no influence of vorticity on stress. However, the arrival of powerful computers has now made their numerical solution possible. Consequently, an investigation was made into the relative behavior of the classic stress tensor as compared to a vorticity influenced stress tensor. In this work, a vorticity influenced stress tensor is derived. Behavior of its principal axes is examined. Within the context of a linearized one dimensional momentum equation, the asymmetric stress tensor is shown to display a forcing function behavior in phase space under some conditions. Classic heuristic arguments are discussed for assuming no influence of vorticity on stress. Lastly, the behavior of a two dimensional, low speed free shear layer is computed as it transitions from laminar to turbulent flow under the influence of the Stokesian tensor and then the vorticity-influenced tensor. The MacCormack, two dimensional, explicit, time accurate, compressible code is used for this study. GRA

**N87-27139#** California Univ., Berkeley. Coll. of Engineering.
**BOUNDARY LAYER SEPARATION IN 2 AND 3 DIMENSIONAL HIGH SPEED BLOW Final Report, May 1983 - Apr. 1984**
Maurice Holt May 1987 11 p
(Grant AF-AFOSR-0199-83)
(AD-A181301; AFOSR-87-0696TR) Avail: NTIS HC A02/MF A01 CSCL 20D

Laminar boundary flow on cones in supersonic flow was calculated using a modified Method of Integrals to account for the change in velocity profiles in the separated regions. The work was extended to three dimensions and compared to experimental data. Significant progress was made in the modeling of the flows and in particular the regions of separated and reverse flow in the boundary layer. GRA

**N87-27140#** Arizona State Univ., Tempe. Dept. of Mechanical and Aerospace Engineering.
**STUDIES IN THE COMPUTATION OF COMPRESSIBLE VISCOUS FLOWS Annual Report, 15 Feb. 1986 - 14 Feb. 1987**
K.-Y. Fung Feb. 1987 16 p
(Grant AF-AFOSR-0071-83)
(AD-A181323; AFOSR-87-0695TR) Avail: NTIS HC A02/MF A01 CSCL 01A

The thin layer Navier Strokes/Euler code has been modified to implement the method of viscous effect and truncation error. These effects can be injected into the solution of the Euler equations on a grid which is normally to course to account for the viscous effects in the boundary layer. Additionally, studies have been conducted to refine transonic flow computations. By a study of the possible local, near sonic solutions in the hodograph plane, singular solutions have been found which may bridge the gap between smooth shock free flow and the flow with embedded shocks. GRA

**N87-27141#** Naval Ship Research and Development Center, Bethesda, Md.
**AN EXPERIMENTAL INVESTIGATION OF APPENDAGE-FLAT PLATE JUNCTION FLOW. VOLUME 1. DESCRIPTION Final Report**
Stuart C. Dickinson Dec. 1986 66 p
(AD-A181386; DTNSRDC-86/051-Vol-1) Avail: NTIS HC A04/MF A01 CSCL 20D

A horeshoe root vortex secondary flow forms at the junction of a flat plate and an appendage, creating a three dimensional, separated flow. Flow visualizations, pressure measurements on the flat plate, and three dimensional mean and fluctuating velocity measurements were made for two appendage shapes at zero angle of attack with a turbulent incoming boundary layer. The radius of curvature of the leading edge affects the strength of the secondary vortex flow. The vorticity is close to the wall, on the order of the momentum thickness of the incoming boundary layer, and has a flattened shape. The vortex breaks down and the vorticity is conserved as shear layers alongside of and in the wake of the appendage. GRA

**N87-27142#** Minnesota Univ., Minneapolis. Hydraulic Lab.
**AN EXPERIMENTAL INVESTIGATION OF THE INFLUENCE OF AIR BUBBLES ON THE ACOUSTIC RADIATION EFFICIENCY OF TURBULENT SHEAR FLOW**
Roger E. Arndt Apr. 1987 23 p
(Contract N00014-85-K-0265)
(AD-A181395; Rept-256) Avail: NTIS HC A02/MF A01 CSCL 20A

The interaction of a turbulent mean flow with entrained air bubbles is examined. Particular attention was paid to the determination of the relative acoustic radiation efficiencies of bubbles undergoing simple harmonic oscillation and those undergoing splitting. There were three phases to this program: (1) Design and fabrication of a bubble injection system. Redesign and quieting of a turbulent jet facility. (2) Design and fabrication of a facility to study bubble formation noise. Acoustic and high speed observations were made and correlated with new theory developed in this program. (3) Experimental determination of the bubble splitting noise over a range of velocity. Stability theory is being used to explain the results. It can be concluded that splitting noise is the most potent noise source when it occurs. An average increase of 20 dB over single phase jet noise is common. The time scale of each noise pulse is independent of velocity, leading to the conjecture that the splitting process is triggered by turbulence, but the resulting unstable motion is a function of only bubble geometry. The peak sound pressure resulting from the formation of bubbles is dependent on the details of how the bubble was formed. A simple model of this process correlated well with the measured data. GRA

**N87-27143#** Dayton Univ., Ohio.
**FAST ALGORITHM DEVELOPMENT FOR LARGE-EDDY SIMULATION OF CIRCULAR-JET TURBULENCE Annual Technical Report no. 1, 1 Sep. 1985 - 14 Oct. 1986**
L. Krishnamurthy, J. Burkardt, C. A. Hall, J. S. Peterson, and T. A. Porsching Dec. 1986 25 p
(Contract F49620-85-C-0137)
(AD-A181429; UDR-TR-86-131; AFOSR-87-0783TR) Avail: NTIS HC A02/MF A01 CSCL 20D

This research project deals with the computational fluid dynamic investigation of the turbulent mixing layers of several prototype circular-jet configurations. The predictive research addressed the large-eddy simulation computations for the large-scale motions and the subgrid-scale turbulence models for the small-scale motions in the near field downstream of an axisymmetric nozzle. The initial attention is focused on the single free jet expanding into a quiescent environment, with the emphasis on two-dimensional computations and one-point closure models. The numerical algorithm development has examined the applicability of a variable reduction

method, and the simulation of a sustained unsteady motion through weighted combinations of stable and unstable schemes. GRA

**N87-27144#** Naval Postgraduate School, Monterey, Calif.
**EXPERIMENTAL INVESTIGATION OF THE EFFECT OF CURVATURE ON HEAT TRANSFER IN A CURVED RECTANGULAR CHANNEL OF HIGH ASPECT RATIO M.S. Thesis**
John R. Hawk, III Mar. 1987 75 p
(AD-A181449) Avail: NTIS HC A04/MF A01 CSCL 20M

An experimental investigation was conducted to study convective heat transfer in straight and curved rectangular channels of high aspect ratio that approximate plates of infinite extent. Experiments were performed at steady state in the turbulent flow regime with one wall held at a constant heat flux and the opposite wall essentially adiabatic. The effect of curvature induced secondary flow on heat transfer on the concave and convex walls was observed by comparing Nusselt numbers for four different configurations at several different Reynolds numbers. Significant heat transfer enhancement was observed on the concave wall. Correlations for Nusselt number as a function of Reynolds number were calculated for the cases studied. GRA

**N87-27145#** Stanford Univ., Calif. Dept. of Mechanical Engineering.
**ZONAL MODELS FOR INCOMPRESSIBLE FLOWS Annual Progress Report, 1 Jan. - 31 Dec. 1986**
S. J. Kline and J. H. Ferziger 28 Feb. 1987 7 p
(Contract F49620-86-K-0008)
(AD-A181494; AFOSR-87-0621TR) Avail: NTIS HC A02/MF A01 CSCL 20D

A successful Unified Zonal model has been created for the entire class of free-shear flows (wakes, jets and mixing layer) by S. Tzuoo working with J. H. Kline. Results check data within 10% for all well-documented cases including the near and far fields and planar and axisymmetric cases. Programs run in a few minutes in a VAX. The solution provides, for the first time, a sufficient set of non-dimensional governing parameters for the entire class of flows and thus provides both a single model and improved understanding of the physics of free-shear flows. As a class for flows, free shear flows are important in jet engines, combustion systems, separated flows and many other applications. Adequate solutions for the near field of any of these flows has not been available previously even though most applications are in the near field region. Consideration of the processes used suggests that the zonal methods developed will generalize successfully to many other flow types. GRA

**N87-27146#** Minnesota Univ., Minneapolis. Dept. of Mechanical Engineering.
**STUDIES OF GAS TURBINE HEAT TRANSFER AIRFOIL SURFACE AND END-WALL Annual Progress Report, 28 Feb. 1986 - 1 Apr. 1987**
Ernst R. Eckert, Richard J. Goldstein, and Terrence W. Simon Apr. 1987 78 p
(Contract F49620-85-C-0049)
(AD-A181558; AFOSR-87-0701TR) Avail: NTIS HC A05/MF A01 CSCL 21E

This report documents work on the topic of heat transfer from gas turbine airfoil, end-wall and internal passage surfaces. The research is divided into the following subtopics: curvature effects, including transition and film cooling; and airfoil heat transfer, including portions near the endwall. GRA

**N87-27147#** Naval Postgraduate School, Monterey, Calif.
**FURTHER DEVELOPMENT OF A ONE-DIMENSIONAL UNSTEADY EULER CODE FOR WAVE ROTOR APPLICATIONS M.S. Thesis**
David T. Johnston Mar. 1987 204 p
(AD-A181750; NPS67-87-002) Avail: NTIS HC A10/MF A01 CSCL 20D

The wave rotor consists of simple tube-like passages along and around the periphery of a drum which rotates between end walls containing inlet and outlet (partial admission) gas ports. Compression and expansion processes occur in a cyclically periodic unsteady process within the rotor such that a high pressure driver gas is used to compress a low pressure driven gas. The compressed driven gas is led from the outlet port to the combustor and brought back into the rotor as the driver. The EULER1 FORTRAN program for computing one-dimensional unsteady flow based on the QAZID method of Verhoff was extended to provide tracking and correcting of discontinuities, flow to right or left and open and closed end boundary conditions. The program was run on four shock tube test cases to verify accuracy and range of capability of the revised E1DV2 code. Further extensions and test verifications are recommended so that the code is suitable for wave rotor applications. GRA

**N87-27148*#** California Univ., Davis. Dept. of Mechanical Engineering.
**AN INVESTIGATION OF TURBULENCE STRUCTURE IN A LOW-REYNOLDS-NUMBER INCOMPRESSIBLE TURBULENT BOUNDARY Final Report**
B. R. White and C. J. Strataridakis May 1987 63 p
(Contract NCA2-79)
(NASA-CR-180332; NAS 1.26:180332) Avail: NTIS HC A04/MF A01 CSCL 20D

An existing high turbulence intensity level (5%) atmospheric boundary-layer wind tunnel has been successfully converted to a relatively low level turbulence (0.3%) wind tunnel through extensive modification, testing, and calibration. A splitter plate was designed, built, and installed into the wind-tunnel facility to create thick, mature, two-dimensional turbulent boundary layer flow at zero pressure gradient. Single and cross hot-wire measurements show turbulent boundary layer characteristics of good quality with unusually large physical size, i.e., viscous sublayer of the order of 1 mm high. These confirm the potential ability of the tunnel to be utilized for future high-quality near-wall turbulent boundary layer measurements. It compares very favorably with many low turbulence research tunnels. Author

**N87-27149#** Illinois Univ., Urbana.
**GAS-LIQUID FLOW IN PIPELINES Progress Report, 1 Jul. 1986 - 1 Jan. 1987**
T. J. Hanratty Jan. 1987 6 p
(Contract DE-FG02-86ER-13556)
(DE87-008941; DOE/ER-13556/1) Avail: NTIS HC A02/MF A01

This project was initiated on July 1, 1986 to obtain a physical understanding of the flow patterns and the phase interactions that exist for gas/liquid flow in long pipelines. Two facilities are being used: One contains horizontal pipelines of 1 inch, 2 inches and 4 inches. The other has vertical pipes with diameters of 3/4 inch, 1 1/2 inches and 2 1/4 inches. The principal laboratory accomplishments during the first six months of the grant have been the renovation of the horizontal facility so that it can be tilted slightly and be used with more viscous liquids, and the development of a greatly improved method to measure rates of atomization and deposition for vertical annular flows. Measurements of atomization and deposition obtained for air-water flow in a vertical 3/4 inch pipe are much higher quality than presently available in the literature. They support the notion that there is a critical film flow rate below which atomization does not occur and provide the most reliable measurements of this critical flow. A surprising aspect of the measurements of the rate of deposition is the demonstration that the rate of deposition is independent of droplet concentration at large droplet concentrations. DOE

**N87-27150*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**WIND TUNNEL REQUIREMENTS FOR COMPUTATIONAL FLUID DYNAMICS CODE VERIFICATION**
Joseph G. Marvin Jul. 1987 16 p Presented at the AGARD Symposium on Aerodynamic Data Accuracy and Quality Requirements and Capabilities in Wind Tunnel Testing, Naples, Italy, 28 Sep. - 1 Oct. 1987

(NASA-TM-100001; A-87261; NAS 1.15:100001) Avail: NTIS HC A02/MF A01 CSCL 20D

The role of experiment in the development of Computational Fluid Dynamics (CFD) for aerodynamic flow field prediction is discussed. Requirements for code verification from two sources that pace the development of CFD are described for: (1) development of adequate flow modeling, and (2) establishment of confidence in the use of CFD to predict complex flows. The types of data needed and their accuracy differs in detail and scope and leads to definite wind tunnel requirements. Examples of testing to assess and develop turbulence models, and to verify code development, are used to establish future wind tunnel testing requirements. Versatility, appropriate scale and speed range, accessibility for nonintrusive instrumentation, computerized data systems, and dedicated use for verification were among the more important requirements identified. Author

**N87-27151*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.

**TRANSPORT OF PASSIVE SCALARS IN A TURBULENT CHANNEL FLOW**

John Kim and Parviz Moin Jul. 1987 14 p

(NASA-TM-89463; A-87235; NAS 1.15:89463) Avail: NTIS HC A02/MF A01 CSCL 20D

A direct numerical simulation of a turbulent channel flow with three passive scalars at different molecular Prandtl numbers is performed. Computed statistics including the turbulent Prandtl numbers are compared with existing experimental data. The computed fields are also examined to investigate the spatial structure of the scalar fields. The scalar fields are highly correlated with the streamwise velocity; the correlation coefficient between the temperature and the streamwise velocity is as high as 0.95 in the wall region. The joint probability distributions between the temperature and velocity fluctuations are also examined; they suggest that it might be possible to model the scalar fluxes in the wall region in a manner similar to the Reynolds stresses. Author

**N87-27152*#** Scientific Research Associates, Inc., Glastonbury, Conn.

**VELOCIMETRY WITH REFRACTIVE INDEX MATCHING FOR COMPLEX FLOW CONFIGURATIONS, PHASE 1 Final Report**

B. E. Thompson, C. Vafidis, and J. H. Whitelaw Aug. 1987 43 p (Contract NAS8-37320)

(NASA-CR-179160; NAS 1.26:179160) Avail: NTIS HC A03/MF A01 CSCL 20D

The feasibility of obtaining detailed velocity field measurements in large Reynolds number flow of the Space Shuttle Main Engine (SSME) main injector bowl was demonstrated using laser velocimetry and the developed refractive-index-matching technique. An experimental system to provide appropriate flow rates and temperature control of refractive-index-matching fluid was designed and tested. Test results are presented to establish the feasibility of obtaining accurate velocity measurements that map the entire field including the flow through the LOX post bundles: sample mean velocity, turbulence intensity, and spectral results are presented. The results indicate that a suitable fluid and control system is feasible for the representation of complex rocket-engine configurations and that measurements of velocity characteristics can be obtained without the optical access restrictions normally associated with laser velocimetry. The refractive-index-matching technique considered needs to be further developed and extended to represent other rocket-engine flows where current methods either cannot measure with adequate accuracy or they fail. B.G.

**N87-27153*#** Universities Space Research Association, Huntsville, Ala.

**A FINITE ELEMENT COMPUTATIONAL METHOD FOR HIGH REYNOLDS NUMBER LAMINAR FLOWS Interim Report**

Sang-Wook Kim Jul. 1987 48 p (Contract NAS8-35918)

(NASA-CR-179135; NAS 1.26:179135) Avail: NTIS HC A03/MF A01 CSCL 20D

A velocity-pressure integrated, mixed interpolation, Galerkin finite element method for the Navier-Stokes equations is presented. In the method, the velocity variables are interpolated using complete quadratic shape functions, and the pressure is interpolated using linear shape functions which are defined on a triangular element for the two-dimensional case and on a tetrahedral element for the three-dimensional case. The triangular element and the tetrahedral element are contained inside the complete bi- and tri-quadratic elements for velocity variables for two and three dimensional cases, respectively, so that the pressure is discontinuous across the element boundaries. Example problems considered include: a cavity flow of Reynolds numbers 400 through 10,000; a laminar backward facing step flow; and a laminar flow in a square duct of strong curvature. The computational results compared favorably with the finite difference computational results and/or experimental data available. It was found that the present method can capture the delicate pressure driven recirculation zones, that the method did not yield any spurious pressure modes, and that the method requires fewer grid points than the finite difference methods to obtain comparable computational results. Author

**N87-27154*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

**EXPERIMENTAL STUDY OF SHOCK WAVE INTERFERENCE HEATING ON A CYLINDRICAL LEADING EDGE Ph.D. Thesis**

Allan R. Wieting May 1987 267 p

(NASA-TM-100484; NAS 1.15:100484) Avail: NTIS HC A12/MF A01 CSCL 20D

An experimental study of shock wave interference heating on a cylindrical leading edge representative of the cowl of a rectangular hypersonic engine inlet at Mach numbers of 6.3, 6.5, and 8.0 is presented. Stream Reynolds numbers ranged from 0.5 x 106 to 4.9 x 106 per ft. and stream total temperature ranged from 2100 to 3400 R. The model consisted of a 3' dia. cylinder and a shock generation wedge articulated to angles of 10, 12.5, and 15 deg. A fundamental understanding was obtained of the fluid mechanics of shock wave interference induced flow impingement on a cylindrical leading edge and the attendant surface pressure and heat flux distributions. The first detailed heat transfer rate and pressure distributions for two dimensional shock wave interference on a cylinder was provided along with insight into the effects of specific heat variation with temperature on the phenomena. Results show that the flow around a body in hypersonic flow is altered significantly by the shock wave interference pattern that is created by an oblique shock wave from an external source intersecting the bow shock wave produced in front of the body. Author

**N87-27155#** National Engineering Lab., East Kilbride (Scotland). Flow Measurement and Turbomachinery Div.

**STUDIES OF THE FLOW OF AIR IN A MODEL MIXED-FLOW PUMP USING LASER DOPPLER ANEMOMETRY. PART 1: RESEARCH FACILITY AND INSTRUMENTATION**

C. Carey, S. M. Fraser, D. Rachman, and G. Wilson Jul. 1985 60 p Sponsored by the UK Dept of Trade and Industry's Mechanical and Engineering Requirements Board. Prepared in cooperation with Strathclyde Univ., Glasgow, Scotland

(NEL-698-Pt-1; ISSN-0305-1439-Pt-1; ETN-87-99816-Pt-1)

Copyright Avail: NTIS HC A04/MF A01

A research facility was installed to study the behavior of air in a model mixed-flow pump, using a laser Doppler anemometer. The facility allows the detailed investigation of the three-dimensional velocity distributions which exist in the rotating and stationary passages of the model under a variety of operating conditions. The facility, including the model, instrumentation, data acquisition system (hardware and software) and the experimental methods used are described. ESA

**N87-27156#** National Engineering Lab., East Kilbride (Scotland). Flow Measurement and Turbomachinery Div.

**STUDIES OF THE FLOW OF AIR IN A MODEL MIXED-FLOW PUMP BY LASER DOPPLER ANEMOMETRY. PART 2: VELOCITY MEASUREMENTS WITHIN THE IMPELLER**

C. Carey, S. M. Fraser, D. Rachman (Strathclyde Univ., Glasgow, Scotland ), and G. Wilson Nov. 1985 85 p Sponsored by the UK Dept. of Trade and Industry's Mechanical and Engineering Requirements Board
(NEL-699; ISSN-0305-1439; ETN-87-99817) Copyright Avail: NTIS HC A05/MF A01

The behavior of air in the rotor of a model mixed-flow bowl pump was investigated using a laser Doppler anemometer. The model was operated at 4 different flowrates at the same rotational speed (1200 rpm); the best efficiency point, and 3 off-design points in an unstable region of the performance characteristic. For each flowrate, the blade-to-blade distributions of three-dimensional velocities were mapped within the rotor, and at inlet and outlet. The results of the flow surveys show complex flow phenomena occurring within the model, and the way the structure of the flow changes as the flowrate is reduced. The velocity distributions observed at the best efficiency point, and the predictions of a through-flow calculation used in the computer-aided design process for this machine are compared. ESA

**N87-27157#** Sheffield Univ. (England). Dept. of Control Engineering.
**THE NONLINEAR IDENTIFICATION OF A HEAT EXCHANGER**
Y. P. Liu, M. J. Korenberg, S. A. Billings, and M. B. Fadzil Feb. 1987 7 p
(RR-312; ETN-87-90101) Avail: NTIS HC A02/MF A01

The practical application of an orthogonal parameter estimation algorithm is investigated by identifying a nonlinear model of a heat exchanger based on input-output records. A criterion called error reduction ratio is employed to select significant terms in the nonlinear autoregressive moving average model expansion to yield a parsimonious model. The fitted model is compared with a model obtained using a prediction error algorithm coupled with stepwise regression, and validated by computing correlation tests and plotting predicted outputs. ESA

**N87-27158#** Rolls-Royce Ltd., Derby (England).
**JET IMPINGEMENT HEAT TRANSFER: A LITERATURE STUDY**
S. J. Downs 1987 33 p
(PNR90360; ETN-87-90110) Avail: NTIS HC A03/MF A01

Information concerning the heat transfer characteristics of round impinging jets, slot nozzles, and nonimpinging jets is reviewed. Experimentally-determined heat transfer coefficients for impinging jets are higher than theoretical predictions, and results vary widely. This is due to the numerous potential error sources, e.g., compressibility, turbulence, crossflow, interference, viscous effects, conduction and radiation. Reasons for measured heat transfer coefficients being higher than predicted values include differing boundary conditions, measuring techniques, characteristic dimensions, and variable ranges. All investigations consider a steady state situation. A Reynolds number coeffiecient range of 0.74 to 0.86 dependant upon x/d and z/d is cited, and the SJD014 is recommended. ESA

**N87-27159#** Rolls-Royce Ltd., Derby (England).
**COMPUTATION OF FLOW AND HEAT TRANSFER IN ROTATING DISC SYSTEMS**
J. W. Chew 5 Nov. 1986 8 p Presented at the 2nd ASME-JSME Thermal Engineering Conference, Mar. 1987
(PNR90363; ETN-87-90111) Copyright Avail: NTIS HC A02/MF A01

Finite difference solutions for turbulent, recirculating flow in rotating disk systems at high rotational Reynolds numbers are presented. The mean flow is assumed steady and axisymmetric and a mixing length model of turbulence is used. Results are compared with integral solutions and experimental data. Agreement between finite difference results and measurements is acceptable for many engineering calculations. Integral methods also show promise, although difficulties are identified, and may be used within large heat conduction programs to supply the convective heat transfer boundary conditions. ESA

**N87-27160#** Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Direction Scientifique de la Resistance des Structures.
**LEA: A COMPUTER PROGRAM FOR ELASTOACOUSTIC CHANNELS WITH FLOW (USER MANUAL) [LEA: UN LOGICIEL LIGNE ELASTO-ACOUSTIQUE AVEC ECOULEMENT (MODE DEMPLOI)]**
N. Piet Sep. 1986 17 p In FRENCH
(Contract CNES-84-3008)
(ONERA-RT-4/3596-RY-050-R; ETN-87-90122) Avail: NTIS HC A02/MF A01

A code to model an elastic channel with a slowly varying section, with an arbitrary form center line, and a compressible flow through it is explained. The program is based on a finite element approach and the model developed by Piet, which is a finite element dynamic model of an elastoacoustic beam in the presence of fluid flow. ESA

**N87-27161*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**APPLICATION OF TURBULENCE MODELING TO PREDICT SURFACE HEAT TRANSFER IN STAGNATION FLOW REGION OF CIRCULAR CYLINDER**
Chi R. Wang and Frederick C. Yeh Sep. 1987 25 p
(NASA-TP-2758; E-3418; NAS 1.60:2758) Avail: NTIS HC A02/MF A01 CSCL 20D

A theoretical analysis and numerical calculations for the turbulent flow field and for the effect of free-stream turbulence on the surface heat transfer rate of a stagnation flow are presented. The emphasis is on the modeling of turbulence and its augmentation of surface heat transfer rate. The flow field considered is the region near the forward stagnation point of a circular cylinder in a uniform turbulent mean flow. The free stream is steady and incompressible with a Reynolds number of the order of 10 to the 5th power and turbulence intensity of less than 5 percent. For this analysis, the flow field is divided into three regions: (1) a uniform free-stream region where the turbulence is homogeneous and isotropic; (2) an external viscid flow region where the turbulence is distorted by the variation of the mean flow velocity; and, (3) an anisotropic turbulent boundary layer region over the cylinder surface. The turbulence modeling techniques used are the kappa-epsilon two-equation model in the external flow region and the time-averaged turbulence transport equation in the boundary layer region. The turbulence double correlations, the mean velocity, and the mean temperature within the boundary layer are solved numerically from the transport equations. The surface heat transfer rate is calculated as functions of the free-stream turbulence longitudinal microlength scale, the turbulence intensity, and the Reynolds number. Author

# 35 INSTRUMENTATION AND PHOTOGRAPHY

Includes remote sensors; measuring instruments and gages; detectors; cameras and photographic supplies; and holography.

For aerial photography see *43 Earth Resources and Remote Sensing.* For related information see also *06 Aircraft Instrumentation,* and *19 Spacecraft Instrumentation.*

**N87-27162#** Oklahoma State Univ., Stillwater. Electronics Lab.
**HIGH DENSITY DIGITAL DATA RECORDING SYSTEM**
Jack Allison and Thomas Bertenshaw 28 Jan. 1987 43 p
(Contract F19628-85-C-0006)
(AD-A181115; AFGL-TR-87-0044; SR-3) Avail: NTIS HC A03/MF A01 CSCL 14C

The state-of-the-art in High Density Digital Data Recording is such that it is now possible to evaluate the capabilities of write-once-read-many (WORM) laser disc systems vis-a-vis magnetic tape spooling. Most of such a systems' components can be purchased off the shelf. The potential to store unalterable data, in vast amounts, in a small space, or a medium impervious

to time degradation can be realized with current technology.
GRA

**N87-27163#** Georgia Inst. of Tech., Atlanta. Biomedical Research Div.
**DEVELOPMENT OF A PULSED MILLIMETER-WAVE NETWORK ANALYZER Final Annual Technical Report, 1 Feb. 1984 - 31 Mar. 1986**
Joseph Seals, Steven M. Sharpe, Anita MacDonald, and Robert E. Voeks Nov. 1986 225 p
(Contracts DAMD17-84-C-4021; DA Proj. 3M1-61102-BS-10)
(AD-A181258) Avail: NTIS HC A10/MF A01 CSCL 06L

A pulsed millimeter-wave network analyzer operating in the 40 to 60 GHz band has been developed at Georgia Tech. The network analyzer consists of three custom-built units: (1) a MMW six-port system that includes sensitive superheterodyne receivers; (2) a phaselocked MMW frequency synthesizer; and (3) a microprocessor-based system controller that provides internal control functions and communication interfaces. An IBM-PC desktop computer is used to input instructions, collect data, and perform required computations. This report summarizes the design, development, and operation of the network analyzer and discusses algorithms used for: (1) calibration of the six-port system, (2) complex reflection coefficient computations, and (3) tissue dielectric property computations. GRA

**N87-27164#** Sandia National Labs., Albuquerque, N. Mex.
**STRAIN GAGING EARTH PENETRATORS TO PROVIDE DYNAMIC FORCE DATA**
R. A. May 1987 7 p Presented at the Society for Experimental Mechanics Spring Meeting, Houston, Tex., 14 Jun. 1987
(Contract DE-AC04-76DP-00789)
(DE87-006126; SAND-87-0401C; CONF-870665-4) Avail: NTIS HC A02

During Earth entry of high speed projectiles large, time-dependent forces are applied to the structure. In order to accurately model the response of these penetrators using both finite element methods and lumped mass-spring models, this force-time relationship must be quantified and used as an input for the analytical models. Two Earth penetrators were internally strain gaged to obtain strains in the penetrator body which could be used to calculate the applied forces. The installation techniques used to install the gages 0.46 m (18 in) from the end of the 127 mm (5 in) inside diameter penetrator case are presented. Gage and adhesive selection as well as wiring and data acquisition techniques designed to survive the high inertial loads encountered during Earth entry are discussed and preliminary results from the first test are shown. DOE

**N87-27206*#** North Carolina Univ., Chapel Hill.
**NONDESTRUCTIVE SEM FOR SURFACE AND SUBSURFACE WAFER IMAGING**
Roy H. Propst, C. Robert Bagnell, Edward I. Cole, Jr., Brian G. Davies, Frank A. DiBianca, Darryl G. Johnson, William V. Oxford, and Craig A. Smith *In* NASA. Langley Research Center, Electronics Reliability and Measurement Technology Aug. 1987 p 17-33 (For primary document see N87-27204 21-38)
Avail: NTIS HC A07/MF A01 CSCL 14B

**N87-27210*#** IRT Corp., San Diego, Calif.
**MICRO-FOCUS X-RAY IMAGING**
Michael Juha *In* NASA. Langley Research Center, Electronics Reliability and Measurement Technology Aug. 1987 p 65-72 (For primary document see N87-27204 21-38)
Avail: NTIS HC A07/MF A01 CSCL 14B

# 36 LASERS AND MASERS

Includes parametric amplifiers.
For related information see also *76 Solid-State Physics.*

**N87-27165*#** Colorado Univ., Boulder. Dept. of Chemistry.
**DESIGN AND CHEMICAL SYNTHESIS OF IODINE-CONTAINING MOLECULES FOR APPLICATION TO SOLAR-PUMPED I* LASERS Semiannual Progress Report, 1 Jul. - 31 Dec. 1986**
Christopher S. Shiner 30 Dec. 1986 13 p
(Grant NAG1-437)
(NASA-CR-180297; NAS 1.26:180297) Avail: NTIS HC A02/MF A01 CSCL 20E

Research is directed toward the design and synthesis of new media for solar-pumped I* lasers. Since the most effective existing lasants are perfluoroalkyl iodides, a strategy was proposed for the development of improved materials of this type with absorption maxima at 300 nm. Absorption spectra were synthesized and measured for prototypical species containing iodine bound to boron, iron, and cobalt. B.G.

**N87-27166*#** Joint Inst. for Lab. Astrophysics, Boulder, Colo.
**ABSOLUTE I* QUANTUM YIELDS FOR THE ICN A STATE BY DIODE LASER GAIN VERSUS ABSORPTION SPECTROSCOPY Semiannual Status Report**
Wayne P. Hess and Stephen R. Leone 1 Jan. 1987 30 p Prepared in cooperation with National Bureau of Standards, Boulder, Colo. and Colorado Univ., Boulder
(Grant NAG1-600)
(NASA-CR-180344; NAS 1.26:180344) Avail: NTIS HC A03/MF A01 CSCL 20E

Absolute I* quantum yields were measured as a function of wavelength for room temperature photodissociation of the ICN A state continuum. The temperature yields are obtained by the technique of time-resolved diode laser gain-versus-absorption spectroscopy. Quantum yields are evaluated at seven wavelengths from 248 to 284 nm. The yield at 266 nm is 66.0 +/- 2% and it falls off to 53.4 +/- 2% and 44.0 +/- 4% at 284 and 248 respectively. The latter values are significantly higher than those obtained by previous workers using infrared fluorescence. Estimates of I* quantum yields obtained from analysis of CN photofragment rotational distributions, as discussed by other workers, are in good agreement with the I* yields. The results are considered in conjunction with recent theoretical and experimental work on the CN rotational distributions and with previous I* yield results.
Author

**N87-27167*#** George Washington Univ., Washington, D.C. Dept. of Electrical Engineering and Computer Science.
**PRE-SHUTTLE LIDAR SYSTEM RESEARCH Final Report, 1 Apr. 1984 - 31 Jul. 1986**
R. H. Lang and M. E. Zaghloul Dec. 1986 83 p
(Contract NCC1-85)
(NASA-CR-180327; NAS 1.26:180327) Avail: NTIS HC A05/MF A01 CSCL 20E

Included are the results of the initial phase of a simulation study in connection with photomultiplier tubes (PMT) and associated networks and an analytical study of atmospheric physics (including multiscattering) leading to modeling studies in connection with differential absorption lidar (DIAL) observations. This effort was in support of the ER-2 aircraft DIAL projects. Author

**N87-27168*#** Old Dominion Univ., Norfolk, Va. Dept. of Mathematical Sciences.
**MATHEMATICAL MODELING OF A Ti:SAPPHIRE SOLID-STATE LASER Final Report, period ending 15 May 1987**
John J. Swetits May 1987 33 p
(Grant NAG1-704)
(NASA-CR-181105; NAS 1.26:181105) Avail: NTIS HC A03/MF A01 CSCL 20E

The project initiated a study of a mathematical model of a tunable Ti:sapphire solid-state laser. A general mathematical model was developed for the purpose of identifying design parameters

which will optimize the system, and serve as a useful predictor of the system's behavior. Author

**N87-27169#** Lawrence Livermore National Lab., Calif.
**MEDIUM POWER Nd(3+): GLASS FIBER ARRAY LASER**
Luis E. Zapata (Miami Univ., Oxford, Ohio.) 22 Apr. 1987 9 p Presented at the Technical Symposium Southeast on Optics, Electro-optics and Sensors, Orlando, Fla., 17-22 May 1987
(Contract W-7405-eng-48)
(DE87-009851; UCRL-96551; CONF-870584-4) Avail: NTIS HC A02/MF A01

For the first time with continuous, moderate power operation of Nd3+:glass fiber bundle laser is reported. The disordered fiber bundle laser consisted of 1450 fibers, each 100 microns in diameter, with 75 micron core, phosphate laser glass doped at 8 wt % Nd2O3. The laser fiber bundle was energized by a xenon flashlamp or a CW argon arc lamp. A maximum energy of 0.8 J at 4.9 kW peak power was obtained in the pulsed flashlamp experiments while the maximum CW power of 25 W was obtained with the arc lamp. The loss coefficient of 0.0266/cm was inferred from the data. Neither the pulsed nor the CW systems were optimized. The beam profile was imaged with low spatial resolution and found to be lobed. Beam structure is indicative of coherence. Calculations for a would-be ordered fiber array laser show that the beam far field approximates a Fraunhoffer diffraction pattern for the total aperture as the beamlets fill the aperture area. DOE

**N87-27170#** Colorado Univ., Boulder. Dept. of Chemistry.
**CHEMICAL STABILIZATION OF LASER DYES Final Report, 1 Dec. 1984 - 28 Feb. 1987**
Tad H. Koch 7 May 1987 9 p
(Contract DAAG29-85-K-0014)
(AD-A180617; ARO-21516.4-CH) Avail: NTIS HC A02/MF A01 CSCL 09C

Coumarin laser dyes upon excitation degrade to produce products which absorb at the lasing wavelength. This results in attenuation of dye laser output through interference of stimulated emission. The roles of singlet oxygen and excitation intensity on dye degradation were explored. Singlet oxygen is formed but its reactions with the dye do not appear to be a major cause of dye laser output deterioration. High light intensity results in dye sensitized, solvent oligomerization to yield materials which interfere with dye stimulated emission. 1, 4-Diazabicyclo2,2,2octane (DABCO)inhibits this oligomerization. GRA

**N87-27171#** Naval Ocean Systems Center, San Diego, Calif.
**MODEL OF LIDAR RETURN IN MARINE STRATUS CLOUD LAYERS Final Technical Report**
V. R. Noonkester Dec. 1986 21 p
(AD-A180636; NOSC/TD-1037) Avail: NTIS HC A02/MF A01 CSCL 17I

Various types of lidars have been used in attempts to obtain quantitative information about the nearby atmosphere. This report investigates the use of a handheld visioceilometer lidar to determine the extinction coefficient sigma as a function of range r at a wavelength lambda of 1.06 micron beneath marine stratus clouds. GRA

**N87-27172#** Naval Research Lab., Washington, D.C. Plasma Theory Branch.
**ANALYSIS OF RADIATION FOCUSING AND GUIDING IN THE FREE ELECTRON LASER BY USE OF A SOURCE DEPENDENT EXPANSION Interim Report**
P. Sprangle, A. Ting (Berkeley Scholars, Inc., Calif.), and C. M. Tang 20 Apr. 1987 44 p Sponsored by US Army Strategic Defense Command, Huntsville, Ala.
(AD-A180923; NRL-MR-5929) Avail: NTIS HC A03/MF A01 CSCL 09C

In the free electron laser (FEL) the resonant interaction between the radiation field and electron beam can result in radiation focusing (optical guiding). If the centroid of the electron beam is transversely displaced off axis, the radiation field, under certain conditions, will follow and be steered by the electron beam. The effect of a spatial modulation on the electron beam envelope can also modify the propagation characteristics of the radiation. These and other phenomena are analytically and numerically studied using a novel source dependent Laguerre-Gaussian modal representation of the fully three dimensional radiation field. Unlike the vacuum Laguerre-Gaussian modal expansion, the longitudinal spatial dependence of the radiation waist and curvature are determined and characterized by the source term in the wave equation. Among the advantages of this general source dependent expansion (SDE) approach is that few modes are needed to accurately describe the radiation. Hence, fast and accurate numerical solutions of the fully three-dimensional FEL problem can be obtained over distances of many Rayleigh lengths. Furthermore, this expansion enables us to drive an envelope equation for the radiation beams as well as an expression for the centroid of the beam. GRA

**N87-27173#** Thermo Electron Corp., Waltham, Mass.
**RESEARCH AND DEVELOPMENT OF PHOTON ACTIVATED THERMIONIC CATHODES FOR EXCIMER LASERS Final Report, 1 Oct. 1984 - 30 May 1985**
P. E. Oettinger Oct. 1986 142 p
(Contract F33615-84-C-2466)
(AD-A180926; TE4362-152-85; AFWAL-TR-86-2066) Avail: NTIS HC A07/MF A01 CSCL 09C

A combined experimental and analytical study was designed to determine whether electron emission from thermally pulsed laser heated cesiated surfaces is due to thermally non-equilibrated thermionic effects, and, if so, to provide a description of the relevant physical processes and their limitations. The experiments were performed with specific pulses of laser radiation incident on tungsten surfaces immersed in a low pressure cesium vapor. The measurements indicated that thermionically generated space charge limited currents are generated, and that their magnitudes could only be accounted for by thermal nonequilibrium effects. The rapidly rising current pulses were often observed to transition into a plasma dominated flow that could be curtailed by diode charges. These experiments and conclusions are discussed in this report in more detail. GRA

**N87-27174#** Washington Univ., Seattle.
**OPTICAL PROPERTIES OF COMPRESSIBLE INHOMOGENEOUS SHEAR LAYERS RELEVANT TO HIGH POWER LASERS Annual Report, Feb. 1985 - Mar. 1986**
Walter H. Christiansen 30 Apr. 1987 13 p
(Grant AF-AFOSR-0059-83)
(AD-A181015; AFOSR-87-0715TR) Avail: NTIS HC A02/MF A01 CSCL 20E

Shear layers and wakes are major sources of optical degradation in flow lasers. The structure of these flows is being studied experimentally with special attention given to their optical properties. Gases with difference refractive indices will be investigated and the effects of density ratio and Mach number on optical performance are being measured. GRA

**N87-27175#** Systems Science and Software, La Jolla, Calif.
**OUTSTANDING PROBLEMS IN HIGH POWER PULSED LASER/TARGET INTERACTIONS Technical Report, 28 Sep. 1983 - 31 Jul. 1984**
B. E. Freeman and P. C. Patnaik 26 Aug. 1986 63 p
(Contract DNA001-83-C-0281; Proj. N99-QAXA)
(AD-A181122; SSS-RR-8123; DNA-TR-86-299) Avail: NTIS HC A04/MF A01 CSCL 09C

An investigation was made of the interaction of a high-power laser beam with a target in air. A laser-supported radiation wave in the air is predicted. Models of this process were developed. An analytic model of the steady-state was compared with a transient numerical model using a one-dimensional radiation/hydrodynamic code. Comparisons with data indicate agreement for Nd-glass frequency laser radiation, but discrepancies for CO2 laser frequency. Speculations are made about the source of the discrepancy. GRA

**N87-27176#** Minnesota Mining and Mfg. Co., St. Paul. Electronic and Information Sector Lab.
**BLUE-GREEN LASER DIODE RESEARCH PROGRAM: REVISION Quarterly Progress Report, 1 Jan. - 31 Mar. 1987**
H. A. Mar, T. L. Smith, and C. T. Walker May 1987 70 p
(Contract N00014-85-C-0552)
(AD-A181447; QPR-4) Avail: NTIS HC A04/MF A01 CSCL 09C

During this reporting period, Na-doping work continued, and, in addition, work began with P- and Sb-doping. The laboratories also began to use a new 6N super high-purity Se source material obtained from Osaka Asahi, with consequent marked improvement in unintentionally-doped material quality. As evident from this report, extrinsic donor impurities from the source materials may be responsible for the difficulties encountered in obtaining p-ZnSe. Efforts in double crystal x-ray rocking curve (DCRC) and transmission electron microscopy studies, as well as e beam and optical pumping, and Schottky and ohmic contact work are continuing. GRA

**N87-27177#** Princeton Univ., N. J. Dept. of Electrical Engineering and Computer Science.
**ULTRAFAST PROCESSES AND SPECTROSCOPY WITH FREE ELECTRON LASERS Annual Report, 1 Jun. 1986 - 31 May 1987**
Philippe M. Fauchet May 1987 17 p
(Contract N00014-86-K-0711)
(AD-A181463) Avail: NTIS HC A02/MF A01 CSCL 09E

Our goal is to demonstrate the power of free electron lasers (FEL) in standard picosecond and femtosecond spectroscopy by performing time-resolved reflectivity or transmission, and wave mixing experiments in semiconductors. Of special interest to us are the carrier relaxation and trapping times in amorphous semiconductors. We report progress on three fronts. First, we have established a permanent laboratory at Stanford University, where we have assembled the necessary equipment. Second, we have developed a novel method to measure accurately and over an extremely wide frequency range the duration and coherence properties of ultrashort laser pulses. This technique has been demonstrated and analyzed successfully at Princeton and appears ideally suited to the characterization of FEL's. Third, results from our recent femtosecond optical spectroscopy studies of amorphous silicon have helped us refine our experimental goals in this program, which will be discussed. GRA

**N87-27178#** Science Research Corp., Somerville, Mass.
**NEW DISCHARGE PUMPING METHOD FOR CO2 LASERS Final Technical Report, 26 Sep. 1986 - 30 May 1987**
Jonah H. Jacob 27 May 1987 52 p
(Contract DAAH01-86-C-1074; ARPA Order 5916)
(AD-A181656; Rept-01-F-1987) Avail: NTIS HC A04/MF A01 CSCL 09C

A new pulsed laser discharge concept is proposed to meet military and civilian requirements for efficient operation of compact, high energy CO2 lasers. This discharge concept promises pulse lengths of up to 100 microseconds duration, scalability to multi-kilojoule pulsed energy, high volumetric efficiency (greater than or = 50 Joules/liter-atm) and high electrical efficiency (greater than or = 20%). This discharge concept relies on a new method for maintaining discharge stability for long pulse durations. This new CO2 laser discharge concept promises increased efficiency, repetition rate, laser pulse length, extracted energy per unit volume and reliability. The concept utilizes a current source to insure volumetric stability. Such a source will not stabilize the discharge against streamer formation. Streamer formation can be inductively inhibited by the use of RF. Hence an RF current source could result in a more stable laser discharge. GRA

**N87-27179#** Los Alamos National Lab., N. Mex.
**SMOKE CLEARING BY HIGH ENERGY LASER BEAMS**
S. M. Chitanvis, S. A. W. Gerstl, and A. Zardecki 10 Apr. 1987 10 p Presented at the Smoke/Obscurants Symposium, Laurel, Md., 21 Apr. 1987
(Contract W-7405-eng-36)
(DE87-009000; LA-UR-87-1294; CONF-8704122-1) Avail: NTIS HC A02/MF A01

We describe the clearing phenomenon that occurs when a continuous wave (CW) high energy laser beam, incident upon a cloud of hygroscopic droplets, vaporizes these droplets. We consider the case when the incident wavelength is greater than the average droplet radius. Williams' model is used to describe the vaporization of a single droplet. The propagation of the laser beam is described by the radiative transfer equation in a slab geometry. The radiative transfer equation is solved using the method of successive orders of scattering. DOE

**N87-27180#** Lawrence Livermore National Lab., Calif.
**DESIGN AND COMPONENT SPECIFICATIONS FOR HIGH AVERAGE POWER LASER OPTICAL SYSTEMS**
R. W. ONeil, R. H. Sawicki, S. A. Johnson, and W. C. Sweatt Jan. 1987 37 p Presented at the Los Angeles Symposium and Exhibition on Optical and Electro-optical Engineering, Los Angeles, Calif., 19 Jan. 1986 Prepared in cooperation with Sandia National Labs., Albuquerque, N. Mex.
(Contracts W-7405-eng-48; DE-AC04-76DP-00789)
(DE87-009136; UCRL-93452; CONF-860117-15) Avail: NTIS HC A03/MF A01

Laser imaging and transport systems are considered in the regime where laser-induced damage and/or thermal distortion have significant design implications. System design and component specifications are discussed and quantified in terms of the net system transport efficiency and phase budget. Optical substrate materials, figure, surface roughness, coatings, and sizing are considered in the context of visible and near-IR optical systems that have been developed at Lawrence Livermore National Laboratory for laser isotope separation applications. In specific examples of general applicability, details of the bulk and/or surface absorption, peak and/or average power damage threshold, coating characteristics and function, substrate properties, or environmental factors will be shown to drive the component size, placement, and shape in high-power systems. To avoid overstressing commercial fabrication capabilities or component design specifications, procedures will be discussed for compensating for aberration buildup, using a few carefully placed adjustable mirrors. By coupling an aggressive measurements program on substrates and coatings to the design effort, an effective technique has been established to project high-power system performance realistically and, in the process, drive technology developments to improve performance or lower cost in large-scale laser optical systems. DOE

**N87-27181#** Sandia National Labs., Albuquerque, N. Mex.
**PORTABLE Nd OSCILLATOR-AMPLIFIER LASER (NOAL) SYSTEM**
M. J. Landry and D. L. Allen Apr. 1987 42 p
(Contract DE-AC04-76DP-00789)
(DE87-010154; SAND-86-0344) Avail: NTIS HC A03/MF A01

A neodymium glass oscillator-amplifier laser (NOAL) system has been installed in an instrumentation trailer. The NOAL system consists of an oscillator and three amplifiers with the laser rods made from ED-2 or phosphate glass. The NOAL system can deliver 500 J (ED-2) or 700 J (phosphate), depending on which glass is used, in a 500 micron pulse. The lasing wavelength is either 1062.3 nm (ED-2) or 1053.5 nm (phosphate). With either type of glass the output beam diameter can be as large as 44 mm with a less than or equal to 2.5-mrad beam divergence. The most reliable operation, which is obtained when only one of the two larger 45-mm-diameter amplifiers is used, delivers about 250 J (ED-2) or 450 J (phosphate) of energy per pulse. An extremely reliable NOAL system, capable of emitting about 800 J per pulse, could be assembled by placing two Lasermetrics oscillator-amplifier systems, each with a large-output Sandia amplifier, on a table in the trailer. DOE

**N87-27182*#** Illinois Univ., Urbana-Champaign. Electro-Optic Systems Lab.
**SINGLE-COLOR LASER RANGING WITH A CUBE-CORNER-RETROREFLECTOR ARRAY**
G. Hugh Song Jun. 1987 73 p
(Grant NsG-5049)
(NASA-CR-180294; NAS 1.26:180294; UILU-ENG-87-2550; EOSL-87-004) Avail: NTIS HC A04/MF A01 CSCL 20E

Lidar cross section of some typical types of cube-corner retroreflectors (CCRs) having a three corner mirror system is investigated for the case that the CCR is tilted from the normal illumination axis. Analytic expressions for the effective aperture area for the two typical window types (circular and hexagonal) of CCRs are obtained for the case that the CCR is tilted. The range of incidence angle in which only the total reflection occurs at all three uncoated corner mirrors has been found to vary considerably with the orientation of CCR and the refractive index of the CCR prism. The analytical expression for the far-field diffraction pattern of a tilted CCR is obtained by taking different polarization transformation of the six sectors of the effective reflecting aperture into account. This expression is essential when evaluating the lidar cross section of a moving CCR which is tilted in general. Formulas for the angles defining the six sectors have also been obtained. Author

**N87-27183** Polytechnic Univ., Brooklyn, N.Y.
**THE DYNAMICS AND COHERENT PROPERTIES OF ELECTRON-BEAM PUMPED SEMICONDUCTOR LASERS Ph.D. Thesis**
Jacob Khurgin 1987 193 p
Avail: Univ. Microfilms Order No. DA8704986

The dynamics and coherence properties of electron beam pumped visible semiconductor lasers were studied over a wide range of operating conditions. Experiments were conducted on a specially designed and built demountable cathode ray tube (CRT) system, enabling quick processing of samples, efficient excitation and simultaneous acquisition of optical and electrical data. Dissert. Abstr.

**N87-27184** Rochester Univ., N. Y.
**STATISTICAL PROPERTIES OF ONE- AND TWO-MODE DYE LASERS Ph.D. Thesis**
Paul David Lett 1986 288 p
Avail: Univ. Microfilms Order No. DA8709504

The statistical properties of the light emitted from one and two mode dye lasers are investigated experimentally, and theoretically, by means of numerical Monte Carlo techniques. The fluctuation and correlation properties of the light intensity emitted from these lasers are characterized experimentally and the findings are then explained in terms of recent theoretical models that include fluctuating pump terms in the nonlinear Langevin-type equations of motion for the electric field in the cavity. The importance of modeling the pump noise with a non-zero correlation time is emphasized in explaining certain features of the intensity autocorrelation. In addition, the mode switching instability present in the two mode dye laser at low excitation levels is investigated. The problem is dealt with in terms of a first passage time problem and, in particular, the effects of pumping fluctuations on the average first passage times and first passage time distributions are examined. Finally, the origins of the mode switching instability are investigated. The possibility of the switching being driven by pump fluctuations is considered as well as the possibility of a deterministically chaotic instability being manifested in the nonlinear equations. Dissert. Abstr.

**N87-27185*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**PRELIMINARY DESIGN AND COST OF A 1-MEGAWATT SOLAR-PUMPED IODIDE LASER SPACE-TO-SPACE TRANSMISSION STATION**
R. J. DeYoung, G. H. Walker, M. D. Williams, G. L. Schuster, and E. J. Conway Sep. 1987 21 p
(NASA-TM-4002; L-16308; NAS 1.15:4002) Avail: NTIS HC A02/MF A01 CSCL 20E

A preliminary conceptual design of a space-based solar pumped iodide laser emitting 1 megawatt of laser power for space-to-space power transmission is described. A near parabolic solar collector focuses sunlight onto the t-C4F9I (perfluoro-t butyl iodide) lasant within a transverse flow optical cavity. Using waste heat, a thermal system was designed to supply compressor and auxiliary power. System components were designed with weight and cost estimates assigned. Although cost is very approximate, the cost comparison of individual system components leads to valuable insights for future research. In particular, it was found that laser efficiency was not a dominant cost or weight factor, the dominant factor being the laser cavity and laser transmission optics. The manufacturing cost was approx. two thirds of the total cost with transportation to orbit the remainder. The flowing nonrenewable lasant comprised 20% of the total life cycle cost of the system and thus was not a major cost factor. The station mass was 92,000 kg without lasant, requiring approx. four shuttle flights to low Earth orbit where an orbital transfer vehicle will transport it to the final altitude of 6378 km. Author

**N87-27186*#** Oregon Graduate Center for Study and Research, Beaverton.
**DYNAMIC CHARACTERISTICS OF FAR-FIELD RADIATION OF CURRENT MODULATED PHASE-LOCKED DIODE LASER ARRAYS Final Technical Report, 1 Feb. 1986 - 31 Jul. 1987**
R. A. Elliott and K. Hartnett Jul. 1987 17 p
(Grant NAG5-734)
(NASA-CR-181002; NAS 1.26:181002) Avail: NTIS HC A02/MF A01 CSCL 20E

A versatile and powerful streak camera/frame grabber system for studying the evolution of the near and far field radiation patterns of diode lasers was assembled and tested. Software needed to analyze and display the data acquired with the steak camera/frame grabber system was written and the total package used to record and perform preliminary analyses on the behavior of two types of laser, a ten emitter gain guided array and a flared waveguide Y-coupled array. Examples of the information which can be gathered with this system are presented. Author

**N87-27187*#** Illinois Univ., Urbana-Champaign. Electro-Optic Systems Lab.
**SINGLE-COLOR LASER RANGING WITH A CUBE-CORNER-RETROREFLECTOR ARRAY**
G. Hugh Song Jun. 1987 73 p
(Grant NsG-5049)
(NASA-CR-181285; NAS 1.26:181285; EOSL-87-004; UILU-ENG-87-2550) Avail: NTIS HC A04/MF A01 CSCL 20E

Lidar cross section of some typical types of cube-corner retroreflectors (CCRs) having a three corner mirror system is investigated for the case that the CCR is tilted from the normal illumination axis. Analytic expressions for the effective aperture area for the two typical window types (circular and hexagonal) of CCRs are obtained for the case that the CCR is tilted. The range of incidence angle in which only the total reflection occurs at all three uncoated corner mirrors has been found to vary considerably with the orientation of CCR and the refractive index of the CCR prisma. The analytical expression for the far-field diffraction pattern of a tilted CCR is obtained by taking different polarization transformation of the six sectors of the effective reflecting aperture into account. This expression is essential when evaluating the lidar cross section of a moving CCR which is tilted in general. Formulas for the angles defining the six sectors have also been obtained. Author

# 37 MECHANICAL ENGINEERING

Includes auxiliary systems (nonpower); machine elements and processes; and mechanical equipment.

**N87-27188** ESDU International Ltd., London (England).
**DESIGN OF DISC CAMS AND THEIR FOLLOWERS: EXAMPLES**
Dec. 1985 66 p
(ESDU-85013-Amend-A; ISBN-0-85679-519-4; ISSN-0141-4096)
Avail: ESDU

ESDU 85013 deals with the design of cam and follower systems. Two fully worked practical design studies are given as examples. Both relate to lightly-loaded moderate-speed applications. The first is a feeder mechanism of a general packaging machine and the design requirement is to meet specified intermediate displacements and velocities to synchronize with associated parts of the machine. The design adopted is a disc cam with translating roller follower using compression springs to maintain follower contact. Profile blending is used, the detailed design of the springs is considered, and the contact stresses and lubricant film thickness are checked to insure a satisfactory design. The second example uses a cognate cam with swinging roller follower to operate the pusher of a conveyer takeoff mechanism. In this case the design is dominated by the stiffness of the system. The period ratio is calculated from the evaluation of the stiffness and an appropriate cam law is chosen. Subsequent calculations determine the basic dimensions, profile shape, follower bearing load capacity, and the selection of a suitable cam material from a knowledge of the contact stresses. ESDU

**N87-27189#** Du Pont de Nemours (E. I.) and Co., Aiken, S.C. Savannah River Lab.
**AUTONOMOUS VEHICLE DEVELOPMENT AT THE SAVANNAH RIVER LABORATORY**
J. J. Fisher, J. S. Byrd, and T. P. Martin 1987 13 p Presented at the 17th ISIR Robotics 2 Conference, Chicago, Ill., 26-30 Apr. 1987
(Contract DE-AC09-76SR-00001)
(DE87-010189; DP-MS-86-191; CONF-870474-2) Avail: NTIS HC A02/MF A01

The Savannah River Laboratory (SRL) is developing intelligent mobile vehicles for deployment in nuclear applications at the Savannah River Plant (SRP). This paper reviews some process applications that have been performed in the nuclear industry with remote teleoperated vehicles and describes approaches of integrating intelligent mobile systems. A control hierarchy is being developed at SRL to allow vehicles to autonomously navigate and perform simple tasks in known environments. Knowledge-based expert systems are being evaluated to assist in navigation functions, to analyze sensory information, and to simplify operator control. Development work using two research vehicles is underway to demonstrate semiautonomous operations in process areas. A description of the mechanical equipment, control systems, and operating modes of these vehicles is presented. DOE

**N87-27190#** Sandia National Labs., Albuquerque, N. Mex.
**MOBILE ROBOT VEHICLES FOR PHYSICAL SECURITY**
Douglas E. McGovern Jun. 1987 4 p Presented at the 28d INMM Annual Meeting on Safeguards: A Mature Technology, Newport Beach, Calif., 12 Jul. 1987
(Contract DE-AC04-76DP-00789)
(DE87-010514; SAND-87-0948C; CONF-870713-2) Avail: NTIS HC A02

A fleet of vehicles is being developed and maintained by Sandia National Labs for studies in remote control and autonomous operation. These vehicles range from modified commercial vehicles to specially constructed mobile platforms and are utilized as test beds for developing concepts in the application of robotics to interior and exterior physical security. Actuators control the vehicle speed, brakes, and steering through manual input from a remote driving station or through some level of digital computer control. On-board processing may include simple vehicle control functions or may allow for unmanned, autonomous operation. Communication links are provided for digital communication between control computers, television transmission for vehicle vision, and voice for local control. With these vehicles, SNL can develop, test, and evaluate sensors, processing requirements, various methods of actuator implementation, operator controlled feedback requirements, and vehicle operations. A description of the major features and uses for each of the vehicles in the fleet is provided. DOE

**N87-27191#** Sandia National Labs., Albuquerque, N. Mex. Advanced Technology Div.
**TECHNOLOGY ASSESSMENT FOR COMMAND AND CONTROL OF TELEOPERATED VEHICLES**
Douglas E. McGovern May 1987 70 p
(Contract DE-AC04-76DP-00789)
(DE87-010990; SAND-87-1225) Avail: NTIS HC A04/MF A01

This paper reviews results in the area of driving studies, simulator applications and vision limitations to approach an understanding of the state of the technology of command and control requirements for teleoperation of mobile vehicles. From this review, a number of significant questions that have a direct bearing on the limits of performance and controllability are identified. These questions include acuity/resolution requirements and limits, monocular versus binocular viewing systems, color or black and white presentation, visual accommodation and magnification effects, training requirements, and the contribution of kinesthetic feedback (motion) to operation. These questions represent limits on the present state of the technology and are identified as areas requiring investigation and development. DOE

**N87-27192#** Rice Univ., Houston, Tex. Dept. of Electrical Engineering.
**MICROWAVE AND VIDEO SENSOR FUSION FOR THE SHAPE EXTRACTION OF SPACE OBJECTS**
Scott W. Shaw, Kumar Krishen, and Rui J. DeFigueiredo Feb. 1987 18 p
(Contracts N00014-85-K-0152; NGT-44-006-806)
(AD-A180984; EE-TR-8706) Avail: NTIS HC A02/MF A01
CSCL 17I

For robots to perform meaningful operations in space, some type of sophisticated vision system is required. Such a system should provide the robot with three dimensional (3D) information about its surrounding work space and the objects on which it will operate. The problem of remotely determining an object's 3D shape is difficult in any situation, but the space environment presents special problems due to the ambient illumination and lack of atmosphere. The exact shape of an object can be determined through the analysis of shading in an optical image, but frequently, shading details are obscured by the high intensity specular reflections which occur in space images. An alternate sensor for robotic applications is microwave radar. Some 3D information is available from time domain radar imaging, but high resolution radar is prohibitively expensive and complex. A new system is proposed for the fusion of optical image data and radar scattering cross sections. The radar data is used in an iterative procedure which generates successive approximations to the target shape by minimizing the error between a computed scattering transfer matrix, and the observed radar returns. GRA

**N87-27193#** Products Research and Chemical Corp., Glendale, Calif.
**DEVELOPMENT OF HIGH TEMPERATURE, IMPROVED PERFORMANCE POLYTHIOETHER SEALANTS, COATINGS AND ADHESIVES Final Report, Sep. 1982 - Sep. 1985**
Lester Morris, David A. Jordan, and Melvin B. Young 30 Jun. 1986 63 p
(Contract N62269-82-C-0370; F61-542)
(AD-A181550; NADC-87071-60) Avail: NTIS HC A04/MF A01
CSCL 11A

Fluid, heat, and electrical properties of polythioether formulations were measured. Effects of sulfur content, curing agents, and stabilizers on properties were examined for high temperature aircraft sealant development. A three to ten fold

increase in retention of elastomeric properties at elevated temperatures to 400 deg. F was observed versus current sealants. The materials' unique characteristics also suggest development of polythioether urethanes for fuel and fluid resistant coatings and lining, electrical sealants and anticorrosion barriers. GRA

**N87-27194#** Stress Technology, Inc., Rochester, N.Y.
**BALANCING OF RIGID AND FLEXIBLE ROTORS**
Neville F. Rieger 1986 623 p
(Contract N00014-75-C-0114)
(AD-A181731) Avail: NTIS HC A99/MF A01 CSCL 13G

Rotor unbalance is a basic concern in the design and operation of machinery because it is a major cause of excessive vibration. An early flexible-rotor balancing technique was based on mode shapes (modal method). Moore demonstrated the practical application of the method to heavy rotating equipment. The controversy between modal and influence coefficient methods began with Goodman's formulation in 1962 of the influence coefficient methods Thearle for flexible rotors. The exact-point speed method, which was developed for multiple planes and speeds, evolved into the least squares method. This method depends heavily on computers, good measurements, and rigid procedures whereas the modal approach involved physical insight. In the late 1970s, the opposing factions, represented by Parkinson of the U.K., an advocate of the modal method, and Smalley of the U.S., an advocate of the influence coefficient method, worked together to develop the unified method of flexible rotor balancing. This method includes aspects of both the modal and influence coefficient methods. GRA

**N87-27195#** Du Pont de Nemours (E. I.) and Co., Aiken, S.C.
**RESIDUAL STRESSES AT PINCH WELDS IN SMALL STAINLESS STEEL TUBES**
W. C. Mosley 1987 6 p Presented at the Conference on Residual Stress in Design, Process, and Materials, Cincinnati, Ohio, 27 Apr. 1987
(Contract DE-AC09-76SR-00001)
(DE87-010186; DP-MS-86-166; CONF-8704128-1) Avail: NTIS HC A02

Stress corrosion cracking of pinch-welded Type 304L stainless steel tubes has been used to determine the locations and magnitudes of tensile residual stresses. Cracking severity, a measure of the extent of tensile stresses above a threshold level, has been correlated with welding parameters and annealing to define conditions that minimize the possibility of environment-assisted slow crack growth on the tube interior. Welding with low current, low electrode force and no restraint, and laser annealing after welding were found to minimize interior stress corrosion cracking at welds in cold drawn tubes. Preliminary work with annealed tubes indicates that pinch welding parameters influence tensile stresses differently. DOE

**N87-27196#** Colorado School of Mines, Golden. Center for Welding Research.
**THE ROLE OF COMPOSITION AND MICROSTRUCTURE GRADIENTS ON WELD METAL PROPERTIES AND BEHAVIOR**
D. L. Olson and D. K. Matlock Nov. 1986 45 p
(Contract DE-FG02-84ER-45066)
(DE87-010407; DOE/ER-45066/T3) Avail: NTIS HC A03/MF A01

The effects of weld metal compositional and microstructural gradients on phase transformations, microstructural stability, and mechanical properties are considered from a fundamental basis in weld metal alloys which are primarily austenitic (e.g., stainless steels). Models which incorporate compositional gradients are developed to predict the resulting weld metal properties. The mechanical properties of weld metals are modeled based on composite theory in which individual weld metal zones are considered as discrete elements within a composite structure. DOE

**N87-27197*#** Ohio State Univ., Columbus. Dept. of Mechanical Engineering.
**THE DESIGN AND ANALYSIS OF SINGLE FLANK TRANSMISSION ERROR TESTER FOR LOADED GEARS Final Report**
Duane E. Bassett and Donald R. Houser Jun. 1987 138 p
(Grant NAG3-541)
(NASA-CR-179621; NAS 1.26:179621; AVSCOM-TR-87-C-15; Rept-764038/716109) Avail: NTIS HC A07/MF A01 CSCL 13I

To strengthen the understanding of gear transmission error and to verify mathematical models which predict them, a test stand that will measure the transmission error of gear pairs under design loads has been investigated. While most transmission error testers have been used to test gear pairs under unloaded conditions, the goal of this report was to design and perform dynamic analysis of a unique tester with the capability of measuring the transmission error of gears under load. This test stand will have the capability to continuously load a gear pair at torques up to 16,000 in-lb at shaft speeds from 0 to 5 rpm. Error measurement will be accomplished with high resolution optical encoders and the accompanying signal processing unit from an existing unloaded transmission error tester. Input power to the test gear box will be supplied by a dc torque motor while the load will be applied with a similar torque motor. A dual input, dual output control system will regulate the speed and torque of the system. This control system's accuracy and dynamic response were analyzed and it was determined that proportional plus derivative speed control is needed in order to provide the precisely constant torque necessary for error-free measurement. Author

**N87-27061#** Vermont Univ., Burlington.
**MECHANICAL SIGNATURE ANALYSIS**
M. S. Hundal *In* Vibration Inst., The Shock and Vibration Digest, volume 18, no. 12 Dec. 1986 p 3-10 (For primary document see N87-27060 21-31)
Avail: NTIS HC A08/MF A01

# 38 QUALITY ASSURANCE AND RELIABILITY

Includes product sampling procedures and techniques; and quality control.

**N87-27198*#** Virginia Univ., Charlottesville. Dept. of Computer Science.
**DETECTION OF FAULTS AND SOFTWARE RELIABILITY ANALYSIS Semiannual Progress Report**
John C. Knight Feb. 1987 82 p
(Grant NAG1-605)
(NASA-CR-180346; NAS 1.26:180346; UVA/528243/CS87/102)
Avail: NTIS HC A05/MF A01 CSCL 14D

Multi-version or N-version programming is proposed as a method of providing fault tolerance in software. The approach requires the separate, independent preparation of multiple versions of a piece of software for some application. These versions are executed in parallel in the application environment; each receives identical inputs and each produces its version of the required outputs. The outputs are collected by a voter and, in principle, they should all be the same. In practice there may be some disagreement. If this occurs, the results of the majority are taken to be the correct output, and that is the output used by the system. A total of 27 programs were produced. Each of these programs was then subjected to one million randomly-generated test cases. The experiment yielded a number of programs containing faults that are useful for general studies of software reliability as well as studies of N-version programming. Fault tolerance through data diversity and analytic models of comparison testing are discussed. B.G.

**N87-27199#** University of Southeastern Massachusetts, North Dartmouth. Dept. of Electrical and Computer Engineering.
**A SIGNAL PROCESSING STUDY OF ULTRASONIC NONDESTRUCTIVE EVALUATION OF MATERIALS Final Report, 1 Oct. 1985 - 30 Sep. 1986**
C. H. Chen Feb. 1987 97 p
(Contract DAAL04-86-K-0002)
(AD-A180648; MTL-TR-87-11) Avail: NTIS HC A05/MF A01 CSCL 14B

In this research the use of modern signal processing and digital pattern recognition in ultrasonic NDE of materials is examined. The high resolution Burg's maximum entropy spectral analysis is shown to provide vital information on the differences among various defect geometries in an aluminum plate. A number of important features computed from the power spectrum have been identified, which in conjunction with correlation matching and by using multi-transducer data can effectively classify the test specimen into three major categories: flat, angular cut, and circular holes and to determine the angles in a multi-stage classification procedure. Size estimation is still a problem that requires further study. Three deconvolution methods are examined and useful features are extracted from the deconvolved results. Research clearly shows that the effectiveness of ultrasonic spectroscopy can be significantly improved by using modern digital signal processing and digital pattern recognition. GRA

**N87-27200#** Army Missile Command, Redstone Arsenal, Ala. Systems Analysis Div.
**THE DISCRETE PROBABILITY DISTRIBUTION FOR r FAILURES IN A DEFINED TIME INTERVAL WHEN THE TIME-TO-FAILURE IS WEIBULLY DISTRIBUTED THROUGHOUT Final Report**
Patrick B. Lawler, Jr. 30 Jan. 1987 144 p
(AD-A180785; AD-E950971; AMSMI/TR-OR-SA-87-1) Avail: NTIS HC A07/MF A01 CSCL 14D

Described is the development of a probability distribution function for the discrete random variable, number of failures, observed in a time interval consisting of T hours when the operating system's time-to-failure is distributed as a two parameter Weibull distribution. Particular application of the distribution is envisioned in repair/spare parts quantity forecasting. Additionally, discussions are provided pertaining to the distribution's goodness-of-fit to simulated Weibull failure times and its use in evaluating stock-out risks associated with discrete stockage levels. Author (GRA)

**N87-27201#** Rome Air Development Center, Griffiss AFB, N.Y.
**INTRODUCTION TO RELIABILITY DEMONSTRATION TESTING OF NONELECTRONIC COMPONENTS Report, May 1982 - May 1985**
John P. LaFollette Feb. 1987 129 p
(AD-A181112; RADC-TM-86-21) Avail: NTIS HC A07/MF A01 CSCL 14B

This report is intended as an instructional manual in demonstration testing of nonelectronic components. Primary emphasis is on truncated tests. Starting from a basic binomial model, the trade-offs between sample size, consumer risk, rejection number and the expected probability of failure are explored. The Weibull distribution is a flexible model for representing mechanical failure modes where reliability degrades with time (a hazard rate that increases with time). The time of test termination follows from the appropriate failure model and the desired reliability. Techniques are presented for analyzing truncated failure data to determine an appropriate failure model. The problems and advantages of using current military test specifications, designed for an exponential failure model, when testing mechanical components, are discussed in detail. The Probability Ratio Sequential Test (PRST) is discussed as an alternative to the truncated test. A variety of PRSTs for different failure models is presented. The Weibull PRST and the exponential PRST are compared. GRA

**N87-27202#** Naval Surface Weapons Center, Dahlgren, Va.
**DATA PROCESSING SYSTEM SPECIFICATIONS FOR THE GEOSAT SATELLITE RADAR ALTIMETER Final Report**
Gladys B. West Jun. 1986 56 p
(AD-A181113; NSWC/TR-86-149) Avail: NTIS HC A04/MF A01 CSCL 17G

This report provides an overview of the Naval Surface Weapons Center's segment of the GEOSAT satellite project; specifically, it documents the radar altimeter data analysis and reduction system. Through the data channels described, radar altimeter measurements collected aboard GEOSAT are converted into best-estimated along-track heights and vertical deflections. GRA

**N87-27203#** Northwestern Univ., Evanston, Ill. Dept. of Mechanical and Nuclear Engineering.
**MONTE CARLO RELIABILITY ANALYSIS Annual Technical Report, 1 Sep. 1985 - 31 Aug. 1986**
E. E. Lewis and Zhuguo Tu 1 Dec. 1986 13 p
(Grant AF-AFOSR-0340-84)
(AD-A181406; AFOSR-87-0790TR) Avail: NTIS HC A02/MF A01 CSCL 14D

The work carried out during the 1985/86 contract year is summarized: Markov Monte Carlo methods are generalized to include inhomogeneous Markov processes. Two new sampling techniques allow the treatment of reliability problems which include time-dependent failure rates and preventive maintenance. Incorporation of periodic testing and repair allows classes of revealed and unrevealed failures to be combined in problems with wear, periodic maintenance and component dependencies. GRA

**N87-27204*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**ELECTRONICS RELIABILITY AND MEASUREMENT TECHNOLOGY**
Joseph S. Heyman, ed. Aug. 1987 143 p Conference held in Hampton, Va., 3-5 Jun. 1986; sponsored by NASA Langley Research Center, USAF, National Security Industrial Association, and the Aerospace Industry Association
(NASA-CP-2472; L-16315; NAS 1.55:2472) Avail: NTIS HC A07/MF A01 CSCL 14D

A summary is presented of the Electronics Reliability and Measurement Technology Workshop. The meeting examined the U.S. electronics industry with particular focus on reliability and state-of-the-art technology. A general consensus of the approximately 75 attendees was that 'the U.S. electronics industries are facing a crisis that may threaten their existence'. The workshop had specific objectives to discuss mechanisms to improve areas such as reliability, yield, and performance while reducing failure rates, delivery times, and cost. The findings of the workshop addressed various aspects of the industry from wafers to parts to assemblies. Key problem areas that were singled out for attention are identified, and action items necessary to accomplish their resolution are recommended. For individual titles, see N87-27205 through N87-27213.

**N87-27205*#** Semiconductor Research Corp., Research Triangle Park, N.C.
**MEASUREMENT SCIENCE AND MANUFACTURING SCIENCE RESEARCH**
D. Howard Phillips *In* NASA. Langley Research Center, Electronics Reliability and Measurement Technology Aug. 1987 p 7-16
(For primary document see N87-27204 21-38)
Avail: NTIS HC A07/MF A01 CSCL 14D

The research program of Semiconductor Research Corp. is managed as three overlapping areas: Manufacturing Sciences, Design Sciences and Microstructure Sciences. A total of 40 universities are participating in the performance of over 200 research tasks. The goals and direction of Manufacturing Sciences research became more clearly focused through the efforts of the Manufacturing Sciences Committee of the SRC Technical Advisory Board (TAB). The mission of the SRC Manufacturing Research is the quantification, control, and understanding of semiconductor manufacturing process necessary to achieve a predictable and profitable product output in the competitive environment of the next decade. The 1994 integrated circuit factory must demonstrate a three level hierarchy of control: (1) operation control, (2) process

control, and (3) process design. These levels of control are briefly discussed. Author

**N87-27206*#** North Carolina Univ., Chapel Hill.
**NONDESTRUCTIVE SEM FOR SURFACE AND SUBSURFACE WAFER IMAGING** **c35**
Roy H. Propst, C. Robert Bagnell, Edward I. Cole, Jr., Brian G. Davies, Frank A. DiBianca, Darryl G. Johnson, William V. Oxford, and Craig A. Smith *In* NASA. Langley Research Center, Electronics Reliability and Measurement Technology Aug. 1987 p 17-33 (For primary document see N87-27204 21-38)
Avail: NTIS HC A07/MF A01 CSCL 14B

The scanning electron microscope (SEM) is considered as a tool for both failure analysis as well as device characterization. A survey is made of various operational SEM modes and their applicability to image processing methods on semiconductor devices. Author

**N87-27207*#** IBM Research Lab., Yorktown Heights, N. Y.
**SURFACE INSPECTION: RESEARCH AND DEVELOPMENT**
J. S. Batchelder *In* NASA. Langley Research Center, Electronics Reliability and Measurement Technology Aug. 1987 p 35-43 (For primary document see N87-27204 21-38)
Avail: NTIS HC A07/MF A01 CSCL 14D

Surface inspection techniques are used for process learning, quality verification, and postmortem analysis in manufacturing for a spectrum of disciplines. First, trends in surface analysis are summarized for integrated circuits, high density interconnection boards, and magnetic disks, emphasizing on-line applications as opposed to off-line or development techniques. Then, a closer look is taken at microcontamination detection from both a patterned defect and a particulate inspection point of view. Author

**N87-27208*#** Unisys Corp., Saint Paul, Minn. Semiconductor Operations.
**WAFER LEVEL RELIABILITY FOR HIGH-PERFORMANCE VLSI DESIGN**
Bryan J. Root and James D. Seefeldt *In* NASA. Langley Research Center, Electronics Reliability and Measurement Technology Aug. 1987 p 45-57 (For primary document see N87-27204 21-38)
Avail: NTIS HC A07/MF A01 CSCL 14D

As very large scale integration architecture requires higher package density, reliability of these devices has approached a critical level. Previous processing techniques allowed a large window for varying reliability. However, as scaling and higher current densities push reliability to its limit, tighter control and instant feedback becomes critical. Several test structures developed to monitor reliability at the wafer level are described. For example, a test structure was developed to monitor metal integrity in seconds as opposed to weeks or months for conventional testing. Another structure monitors mobile ion contamination at critical steps in the process. Thus the reliability jeopardy can be assessed during fabrication preventing defective devices from ever being placed in the field. Most importantly, the reliability can be assessed on each wafer as opposed to an occasional sample. Author

**N87-27209*#** Technology Associates, Inc., Portola Valley, Calif.
**WAFER LEVEL RELIABILITY TESTING: AN IDEA WHOSE TIME HAS COME**
O. D. Trapp *In* NASA. Langley Research Center, Electronics Reliability and Measurement Technology Aug. 1987 p 59-63 (For primary document see N87-27204 21-38)
Avail: NTIS HC A07/MF A01 CSCL 14D

Wafer level reliability testing has been nurtured in the DARPA supported workshops, held each autumn since 1982. The seeds planted in 1982 have produced an active crop of very large scale integration manufacturers applying wafer level reliability test methods. Computer Aided Reliability (CAR) is a new seed being nurtured. Users are now being awakened by the huge economic value of the wafer reliability testing technology. Author

**N87-27210*#** IRT Corp., San Diego, Calif.
**MICRO-FOCUS X-RAY IMAGING** **c35**
Michael Juha *In* NASA. Langley Research Center, Electronics Reliability and Measurement Technology Aug. 1987 p 65-72 (For primary document see N87-27204 21-38)
Avail: NTIS HC A07/MF A01 CSCL 14B

The acceptance of surface mounting in the electronics industry has been slowed by problems with component availability, electrical testing, and inspection. Industry suppliers and users have been working to solve these problems, and they are easing. Component manufacturers are offering substantially more devices in surface mountable packages. Automated test equipment vendors are offering test fixtures for surface mount circuit boards. And just recently, solder connection inspection has been automated through a partership effort with a major electronics manufacturer. The results achieved in this effort are presented. Author

**N87-27211*#** Wayne State Univ., Detroit, Mich. Dept. of Physics.
**MEASUREMENT OF OPAQUE FILM THICKNESS**
R. L. Thomas, J. Jaarinen (Helsinki Univ., Finland ), C. Reyes, I. C. Oppenheim, L. D. Favro, and P. K. Kuo *In* NASA. Langley Research Center, Electronics Reliability and Measurement Technology Aug. 1987 p 73-83 (For primary document see N87-27204 21-38)
(Contracts DAAG29-84-K-0173; W-7405-eng-82)
Avail: NTIS HC A07/MF A01 CSCL 14D

The theoretical and experimental framework for thickness measurements of thin metal films by low frequency thermal waves is described. Although it is assumed that the films are opaque and the substrates are comparatively poor thermal conductors, the theory is easily extended to other cases of technological interest. A brief description is given of the thermal waves and the experimental arrangement and parameters. The usefulness of the technique is illustrated for making absolute measurements of the thermal diffusivities of isotropic substrate materials. This measurement on pure elemental solids provides a check on the three dimensional theory in the limiting case of zero film thickness. The theoretical framework is then presented, along with numerical calculations and corresponding experimental results for the case of copper films on a glass substrate. Author

**N87-27212*#** Vanzetti Systems, Inc., Stoughton, Mass.
**INTELLIGENT LASER SOLDERING INSPECTION AND PROCESS CONTROL** **c31**
Riccardo Vanzetti *In* NASA. Langley Research Center, Electronics Reliability and Measurement Technology Aug. 1987 p 85-94 (For primary document see N87-27204 21-38)
Avail: NTIS HC A07/MF A01 CSCL 13H

Component assembly on printed circuitry keeps making giant strides toward denser packaging and smaller dimensions. From a single layer to multilayer, from through holes to surface mounted components and tape applied bonds, unrelenting progress results in new, difficult problems in assembling, soldering, inspecting and controlling the manufacturing process of the new electronics. Among the major problems are the variables introduced by human operators. The small dimensions and the tight assembly tolerances are now successfully met by machines which are faster and more precise than the human hand. The same is true for soldering. But visual inspection of the solder joints is now so severely limited by the ever shrinking area accessible to the human eye that the inspector's diagnosis cannot be trusted any longer. Solutions to correcting these problems are discussed. Author

**N87-27213*#** General Electric Co., Syracuse, N.Y.
**RUPTURE TESTING FOR THE QUALITY CONTROL OF ELECTRODEPOSITED COPPER INTERCONNECTIONS IN HIGH-SPEED, HIGH-DENSITY CIRCUITS**
Louis Zakraysek *In* NASA. Langley Research Center, Electronics Reliability and Measurement Technology Aug. 1987 p 95-12 (For primary document see N87-27204 21-38)
Avail: NTIS HC A07/MF A01 CSCL 14D

Printed Wiring Multilayer Board (PWMLB) structures for high speed, high density circuits are prone to failure due to the microcracking of electrolytic copper interconnections. The failure

can occur in the foil that makes up the inner layer traces or in the plated through holes (PTH) deposit that forms the layer to layer interconnections. It is shown that there are some distinctive differences in the quality of Type E copper and that these differences can be detected before its use in a PWMLB. It is suggested that the strength of some Type E copper can be very low when the material is hot and that it is the use of this poor quality material in a PWMLB that results in PTH and inner layer microcracking. Since the PWMLB failure in question are induced by a thermal stress, and since the poorer grades of Type E materials used in these structures are susceptible to premature failure under thermal stress, the use of elevated temperature rupture and creep rupture testing is proposed as a means for screening copper foil, or its PTH equivalent, in order to eliminate the problem of Type E copper microcracking in advanced PWMLBs. Author

**N87-27214#** Lawrence Livermore National Lab., Calif.
**COLORAD SYSTEM FOR MAPPING ELEMENTAL COMPOSITION DETERMINED BY X-RAY ANALYSIS**
D. D. McCoy Mar. 1987 7 p Presented at the 22nd Annual Meeting of the Microbeam Analysis Society, Kailua-Kona, Hawaii, 13 Jul. 1987
(Contract W-7405-eng-48)
(DE87-008472; UCRL-95935; CONF-870725-7) Avail: NTIS HC A02/MF A01

Colorad is a color-imaging system that maps concentrations and phase distributions of elements in a designated region of a material by analysis of X-ray signals generated in the material by a scanning electron beam. Color variations show the amounts of different elements present and the composition of the phases. The instrument measures the intensity of each element's characteristic X-ray signal, then assigns a lightness to represent the concentration of a selected element, and a color (characterized by hue, value, and chroma) for a given combination of elements. The color display is unambiguously associated with concentration levels, permitting elemental analysis of concentrations as low as 0.5%. Because the brightness of the image is independent of signal strength, the instrument is particularly valuable for determining the composition of phases present. A typical use of Colorad is in analyzing the material in the vicinity of a braze joint to determine the quality of the braze. DOE

# 39 STRUCTURAL MECHANICS

Includes structural element design and weight analysis; fatigue; and thermal stress.

For applications see *05 Aircraft Design, Testing and Performance* and *18 Spacecraft Design, Testing and Performance.*

**N87-27215*#** Johns Hopkins Univ., Baltimore, Md. Dept. of Mechanical Engineering.
**CLOSURE MEASUREMENTS ON SHORT FATIGUE CRACKS Annual Report, 11 Oct. 1984 - 10 Oct. 1985**
J. J. Lee and W. N. Sharpe, Jr. 1985 18 p Presented at the ASTM International Symposium on Fatigue Crack Closure, Charleston, S.C., May 1986 Submitted for publication
(Grant NAG1-526)
(NASA-CR-180315; NAS 1.26:180315) Avail: NTIS HC A02/MF A01 CSCL 20K

Single-edged notched specimens, 2.3 mm thick, of 2024-T3 aluminum were cyclicly loaded at R-ratios of 0.5, 0.0, -1.0 and -2.0. The notch roots were periodically inspected with an optical microscope to locate the initiation of very short cracks. Acetate replicas were also taken. The loads were selected to produce fatigue lives of 500,000 cycles or less. Crack opening displacements were measured at single positions across cracks as short as 0.035 mm and as long as the full thickness of the specimen. The opening load ratios for the short cracks are somewhat smaller than for long cracks at positive R-ratios, but are considerably smaller for negative R-ratios. Author

**N87-27216*#** Georgia Inst. of Tech., Atlanta. School of Mechanical Engineering.
**HIGH SPEED, PRECISION MOTION STRATEGIES FOR LIGHTWEIGHT STRUCTURES Final Report**
Wayne J. Book 1987 37 p
(Grant NAG1-623)
(NASA-CR-180338; NAS 1.26:180338; E25-517) Avail: NTIS HC A03/MF A01 CSCL 20K

Abstracts of published papers and dissertations generated during the reporting period are compiled. Work on fine motion control was completed. Specifically, real time control of flexible manipulator vibrations were experimentally investigated. A linear model based on the application of Lagrangian dynamics to a rigid body mode and a series of separable flexible modes was examined with respect to model order requirements, and modal candidate selection. State feedback control laws were implemented based upon linear quadratic regulator design. Specification of the closed loop poles in the regulator design process was obtained by inclusion of a prescribed degree of stability in the manipulator model. Work on gross motion planning and control is also summarized. A systematic method to symbolically derive the full nonlinear dynamic equations of motion of multi-link flexible manipulators was developed. M.G.

**N87-27217*#** Old Dominion Univ., Norfolk, Va. Dept. of Civil Engineering.
**TWO-DIMENSIONAL FINITE ELEMENT ANALYSIS OF RECTANGULAR PANEL WITH HOLE USING NICE/SPAR Progress Report, period ended 31 Dec. 1986**
Zia Razzaq, Venkatesh Prasad, and Siva Prasad Darbhamulla Apr. 1987 28 p
(Grant NAG1-438)
(NASA-CR-180630; NAS 1.26:180630) Avail: NTIS HC A03/MF A01 CSCL 20K

A panel 30 in. long, 11.5 in. wide, with a 2.0 in. diameter hole at the center is analyzed. Since a two-dimensional analysis is conducted, the thickness of the panel is taken as unity. Owing to the symmetry, it is sufficient to analyze only one fourth of the panel with appropriate boundary conditions. Author

**N87-27218*#** Florida Atlantic Univ., Boca Raton. Center for Acoustics and Vibration.
**ESTIMATING THE VIBRATION LEVEL OF AN L-SHAPED BEAM USING POWER FLOW TECHNIQUES**
J. M. Cuschieri, M. McCollum, J. L. Rassineux, and T. Gilbert [1986] 7 p
(Grant NAG1-685)
(NASA-CR-180680; NAS 1.26:180680) Avail: NTIS HC A02/MF A01 CSCL 20K

The response of one component of an L-shaped beam, with point force excitation on the other component, is estimated using the power flow method. The transmitted power from the source component to the receiver component is expressed in terms of the transfer and input mobilities at the excitation point and the joint. The response is estimated both in narrow frequency bands, using the exact geometry of the beams, and as a frequency averaged response using infinite beam models. The results using this power flow technique are compared to the results obtained using finite element analysis (FEA) of the L-shaped beam for the low frequency response and to results obtained using statistical energy analysis (SEA) for the high frequencies. The agreement between the FEA results and the power flow method results at low frequencies is very good. SEA results are in terms of frequency averaged levels and these are in perfect agreement with the results obtained using the infinite beam models in the power flow method. The narrow frequency band results from the power flow method also converge to the SEA results at high frequencies. The advantage of the power flow method is that detail of the response can be retained while reducing computation time, which will allow the narrow frequency band analysis of the response to be extended to higher frequencies. Author

**N87-27219*#** Iowa Univ., Iowa City. Center for Computer Aided Design.
**DESIGN SENSITIVITY ANALYSIS AND OPTIMIZATION OF BUILT-UP STRUCTURES Final Technical Report, Oct. 1981 - Dec. 1986**
Kyung K. Choi and Edward J. Haug [1987] 23 p
(Grant NAG1-215)
(NASA-CR-180973; NAS 1.26:180973) Avail: NTIS HC A02/MF A01 CSCL 20K

Developments during the course of the research in design sensitivity analysis and optimization of built-up structures, with both sizing and shape design variables, show clearly that a unified variational approach to design sensitivity analysis can yield derivatives of structural response with respect to design. Rigorous and practically computable results for structural components and built-up structures have been demonstrated and used to solve design optimization problems. Author

**N87-27220*#** Iowa Univ., Iowa City. Center for Computer Aided Design.
**DESIGN SENSITIVITY ANALYSIS WITH APPLICON IFAD USING THE ADJOINT VARIABLE METHOD**
Marjorie C. Frederick and Kyung K. Choi Dec. 1984 142 p
(Grant NAG1-215)
(NASA-CR-181101; NAS 1.26:181101; TR-84-17) Avail: NTIS HC A07/MF A01 CSCL 20K

A numerical method is presented to implement structural design sensitivity analysis using the versatility and convenience of existing finite element structural analysis program and the theoretical foundation in structural design sensitivity analysis. Conventional design variables, such as thickness and cross-sectional areas, are considered. Structural performance functionals considered include compliance, displacement, and stress. It is shown that calculations can be carried out outside existing finite element codes, using postprocessing data only. That is, design sensitivity analysis software does not have to be imbedded in an existing finite element code. The finite element structural analysis program used in the implementation presented is IFAD. Feasibility of the method is shown through analysis of several problems, including built-up structures. Accurate design sensitivity results are obtained without the uncertainty of numerical accuracy associated with selection of a finite difference perturbation. Author

**N87-27221*#** Iowa Univ., Iowa City. Center for Computer Aided Design.
**SHAPE DESIGN SENSITIVITY ANALYSIS USING DOMAIN INFORMATION**
Hwal-Gyeong Seong and Kyung K. Choi Apr. 1985 166 p
(Grant NAG1-215)
(NASA-CR-181100; NAS 1.26:181100; TR-85-3) Avail: NTIS HC A08/MF A01 CSCL 20K

A numerical method for obtaining accurate shape design sensitivity information for built-up structures is developed and demonstrated through analysis of examples. The basic character of the finite element method, which gives more accurate domain information than boundary information, is utilized for shape design sensitivity improvement. A domain approach for shape design sensitivity analysis of built-up structures is derived using the material derivative idea of structural mechanics and the adjoint variable method of design sensitivity analysis. Velocity elements and B-spline curves are introduced to alleviate difficulties in generating domain velocity fields. The regularity requirements of the design velocity field are studied. Author

**N87-27222*#** Iowa Univ., Iowa City. Center for Computer Aided Design.
**DESIGN SENSITIVITY ANALYSIS USING EAL. PART 2: SHAPE DESIGN PARAMETERS**
B. Dopker and Kyung K. Choi Jun. 1986 37 p
(Grant NAG1-215)
(NASA-CR-181098; NAS 1.26:181098; TR-86-8-Pt-2) Avail: NTIS HC A03/MF A01 CSCL 20K

A numerical implementation of shape design sensitivity analysis of built-up structures is presented, using the versatility and convenience of an existing finite element structural analysis code and its data base management system. This report is a continuation of a previous report on conventional design parameters. The finite element code used in the implementation presented is the Engineering Analysis Language (EAL), which is based on a hybrid analysis method. It has been shown that shape design sensitivity computations can be carried out using the database management system of EAL, without writing a separate program and a separate data base. The material derivative concept of continuum mechanics and an adjoint variable method of design sensitivity analysis are used to derive shape design sensitivity information of structural performances. A domain method of shape design sensitivity analysis and a design component method are used. Displacement and stress functionals are considered as performance criteria. Author

**N87-27223** ESDU International Ltd., London (England).
**COMPUTER PROGRAM TO EVALUATE ALONG-WIND LOADING AND RESPONSE BASED ON ESDU 76001**
Dec. 1984 19 p
(ESDU-84034; ISBN-0-85679-498-8; ISSN-0141-4003) Avail: ESDU

ESDU 84034 gives a BASIC computer program listing based on the calculation procedures of ESDU 76001 for evaluating the loading and the response, in the wind direction, of a structure to a turbulent wind. It applies to such structures as stacks, lattice towers, masts, flare stacks, beams, cables, bridges, and high-rise buildings with one face normal to the wind. The program calculates the shear force, bending and torsional moments, deflection and acceleration at different points on the structure for a range of mode shapes; a mean component is computed on which is superimposed the maximum fluctuation component, itself consisting of a quasi-static and a dynamic contribution due to the response of the structure at its fundamental natural frequency. Input to the program consists of properties of the structure and details of the site. If the user cannot supply wind speed and turbulence values, the program will calculate values based on a reference wind speed input and assuming uniform terrain upwind. ESDU

**N87-27224** ESDU International Ltd., London (England).
**DESIGN FOR MINIMUM WEIGHT. STRUTS OF UNIFORM SECTION. THIN-WALLED ROUND TUBES**
Jun. 1985 17 p Supersedes ESDU-66005
(ESDU-85014; ESDU-66005; ISBN-0-85679-520-8; ISSN-0141-4097) Avail: ESDU

ESDU 85014 provides graphs that allow the dimensions of the minimum weight strut to be determined with a chosen probability and confidence that overall buckling will occur before local buckling. The use of probability and confidence values related to a statistical analysis given in ESDU 83034 of experimental results that takes into account the effect of local irregularities on local buckling. The effect of eccentricity of loading and initial bow on overall buckling is not taken into account. End conditions can be both ends fixed or pinned, one end fixed and one free, or both ends fixed in rotation but one free in translation. To obtain an optimum standard size tube, the next standard smallest diameter tube to the optimum found from ESDU 85014 is chosen, its thickness increased in standard increments, and each case analyzed using ESDU Struct 01.01.01 until a size that supports the applied load is achieved. Practical worked examples illustrate the use of the data. ESDU

**N87-27225** ESDU International Ltd., London (England).
**FATIGUE CRACK PROPAGATION RATES AND THRESHOLD STRESS INTENSITY FACTORS IN HIGH STRENGTH LOW ALLOY STEEL PLATE, BAR AND FORGINGS**
Jul. 1985 61 p Supersedes ESDU-77005
(ESDU-85019; ESDU-77005; ISBN-0-85679-525-9; ISSN-0141-4089) Avail: ESDU

ESDU 85019 gives graphs showing the rate of increase in crack length per loading cycle plotted against stress intensity factor

range for a large group of steels. The curves were obtained by correlating results taken from the literature for tests on steels of tensile strength from 850 to 1970 MN/sq m (123000 to 286000 lbf/sq in). Specimens were tested under constant amplitude loading at room temperature in laboratory air. Included are details of the test specimens, their loading (mainly tensile axial), and the exact composition of the steels. The influence of fracture toughness, mean stress, and material proof stress can be seen in the data and is discussed. Summary curves are included that show the effect of stress ratio and material proof stress on crack growth rates. Two practical worked examples show how the data may be used to establish the life of a component or whether an existing crack will grow. ESDU

**N87-27226*#** Lehigh Univ., Bethlehem, Pa.
**PLATES AND SHELLS CONTAINING A SURFACE CRACK UNDER GENERAL LOADING CONDITIONS**
Paul F. Joseph and Fazil Erdogan [1986] 390 p
(Grant NAG1-713)
(NASA-CR-181052; NAS 1.26:181052) Avail: NTIS HC A17/MF A01 CSCL 20K

The severity of the underlying assumptions of the line-spring model (LSM) are such that verification with three-dimensional solutions is necessary. Such comparisons show that the model is quite accurate, and therefore, its use in extensive parameter studies is justified. Investigations into the endpoint behavior of the line-spring model have led to important conclusions about the ability of the model to predict stresses in front of the crack tip. An important application of the LSM was to solve the contact plate bending problem. Here the flexibility of the model to allow for any crack shape is exploited. The use of displacement quantities as unknowns in the formulation of the problem leads to strongly singular integral equations, rather than singular integral equations which result from using displacement derivatives. The collocation method of solving the integral equations was found to be better and more convenient than the quadrature technique. Orthogonal polynomials should be used as fitting functions when using the LSM as opposed to simpler functions such as power series. B.G.

**N87-27227*#** Virginia Univ., Charlottesville. Dept. of Materials Science.
**STRESS EFFECTS IN MULTILAYERS Progress Report, 1 Nov. 1986 - 31 Jul. 1987**
W. A. Jesser 1987 40 p
(Grant NAG1-350)
(NASA-CR-181172; NAS 1.26:181172) Avail: NTIS HC A03/MF A01 CSCL 20K

Calculations of interfacial stress in abrupt junctions and its effect on the defect state of the interface are examined. B.G.

**N87-27228#** Vibration Inst., Clarendon Hills, Ill.
**THE SHOCK AND VIBRATION DIGEST, VOLUME 18, NO. 3 Monthly Report**
Judith Nagle-Eshleman, ed. Mar. 1986 81 p
(AD-A167082) Avail: NTIS HC A05/MF A01

A brief discussion of optimization approaches that improve the efficiency of the finite element method is presented. Also, optimization of structures in a shock and vibration environment is discussed. Abstracts from current shock and vibration literature in the areas of structural systems, vehicle systems, mechanical components, structural components, and electrical components are given. For individual titles, see N87-27229 through N87-27230.

**N87-27229#** Institute of Applied Mechanics, Puerto Belgrano Naval Base (Argentina).
**THE COMPUTER AGE AND THE USEFULNESS OF OLD IDEAS**
P. A. A. Laura *In* Vibration Inst., The Shock and Vibration Digest, v. 18, no. 3 Mar. 1986 p 3-5 (For primary document see N87-27228 21-39)
Avail: NTIS HC A05/MF A01

A brief discussion of optimization approaches that improve the efficiency of the finite element method is given. The recently developed k-optimization parameter method for determining natural frequencies and buckling loads is emphasized. Author

**N87-27230#** Purdue Univ., West Lafayette, Ind. School of Mechanical Engineering.
**OPTIMIZATION OF STRUCTURES UNDER SHOCK AND VIBRATION ENVIRONMENT**
S. S. Rao *In* Vibration Inst., The Shock and Vibration Digest, v. 18, no. 3 Mar. 1986 p 7-15 (For primary document see N87-27228 21-39)
Avail: NTIS HC A05/MF A01

Structural optimization problems involving dynamic response calculations are classified according to the physical nature of the problem and the major behavior constraint considered. A summary of recent work in each class is given. Recent work on optimization techniques, including approximate analysis techniques, multilevel design techniques, and multi-objective design procedures, is also presented. Structural optimization problems that need further investigation are summarized. Author

**N87-27231*#** Computer Software Management and Information Center, Athens, Ga.
**FIFTEENTH NASTRAN USERS' COLLOQUIUM**
Aug. 1987 312 p Colloquium held in Kansas City, Mo., 4-8 May 1987
(Contract NASw-3247)
(NASA-CP-2481; NAS 1.55:2481) Avail: NTIS HC A14/MF A01; also available from COSMIC, Athens, Ga. 30602 CSCL 20K

Numerous applications of the NASA Structural Analysis (NASTRAN) computer program, a general purpose finite element code, are discussed. Additional features that can be added to NASTRAN, interactive plotting of NASTRAN data on microcomputers, mass modeling for bars, the design of wind tunnel models, the analysis of ship structures subjected to underwater explosions, and buckling analysis of radio antennas are among the topics discussed. For individual titles, see N87-27232 through N87-27249.

**N87-27232*#** RPK Corp., Columbia, Md.
**ADDITION OF THE AUTOSPC FEATURE TO NASTRAN**
P. R. Pamidi and Horace Q. Turner *In* COSMIC, 15th NASTRAN Users' Colloquium Aug. 1987 p 1-35 (For primary document see N87-27231 21-39)
Avail: NTIS HC A14/MF A01; also available from COSMIC, Athens, Ga. 30602 CSCL 20K

A new capability called the AUTOSPC feature has been incorporated into the April 1987 release of NASTRAN. It gives the user the option of automatically applying single-point constraints for the purpose of removing potential grid and scalar point singularities that have not been otherwise already constrained out. Details of this implementation are given. Its usage is described and it is illustrated with an example problem. Author

**N87-27233*#** Magnavox Electronic Systems Co., Fort Wayne, Ind.
**IBM JCL MADE EASY BY MEANS OF ISPF DIALOG APPLICATION**
Charles E. Cooper *In* COSMIC, 15th NASTRAN Users' Colloquium Aug. 1987 p 36-55 (For primary document see N87-27231 21-39)
Avail: NTIS HC A14/MF A01; also available from COSMIC, Athens, Ga. 30602 CSCL 20K

An interactive cathode ray tube (CRT) terminal application has been developed which automatically generates the job control language (JCL) and submits NASTRAN batch jobs at an IBM mainframe installation. The relevant parameters for each NASTRAN batch job are stored in a table. Once a table entry is defined, the corresponding NASTRAN batch job may be submitted as often as desired with a minimum of keystrokes. For most users, there is no need for any knowledge of JCL. Author

**N87-27234*#** Intergraph Corp., Huntsville, Ala.
**A NEW APPROACH TO FINITE ELEMENT MODELING, ANALYSIS AND POST-PROCESSING**
Gil White *In* COSMIC, 15th NASTRAN Users' Colloquium Aug. 1987 p 56-58 (For primary document see N87-27231 21-39)
Avail: NTIS HC A14/MF A01; also available from COSMIC, Athens, Ga. 30602 CSCL 20K

Recent advances in both hardware and software have opened the door to a new generation of finite element modeling systems. INTERGRAPH CORP has combined an innovative programming concept with a stand alone workstation hardware platform to produce a new standard in finite element modeling called I/FEM. The system offers the COSMIC NASTRAN user full integration between design and analysis. I/FEM not only addresses the needs of the NASTRAN user of today, it also provides for continued evolution of the COSMIC NASTRAN product. Author

**N87-27235*#** Maryland Univ., College Park.
**THE APPLICATION OF NASCAD AS A NASTRAN PRE- AND POST-PROCESSOR**
Alan N. Peltzman *In* COSMIC, 15th NASTRAN Users' Colloquium Aug. 1987 p 59-71 Sponsored by Texas Instruments Corp., Austin (For primary document see N87-27231 21-39)
Avail: NTIS HC A14/MF A01; also available from COSMIC, Athens, Ga. 30602 CSCL 20K

The NASA Computer Aided Design (NASCAD) graphics package provides an effective way to interactively create, view, and refine analytic data models. NASCAD's macro language, combined with its powerful 3-D geometric data base allows the user important flexibility and speed in constructing his model. This flexibility has the added benefit of enabling the user to keep pace with any new NASTRAN developments. NASCAD allows models to be conveniently viewed and plotted to best advantage in both pre- and post-process phases of development, providing useful visual feedback to the analysis process. NASCAD, used as a graphics compliment to NASTRAN, can play a valuable role in the process of finite element modeling. Author

**N87-27236*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**EXPERIENCES RUNNING NASTRAN ON THE MICROVAX 2 COMPUTER**
Thomas G. Butler (Butler Analyses, Towson, Md.) and Reginald S. Mitchell *In* COSMIC, 15th NASTRAN Users' Colloquium Aug. 1987 p 72-87 (For primary document see N87-27231 21-39)
Avail: NTIS HC A14/MF A01; also available from COSMIC, Athens, Ga. 30602 CSCL 20K

The MicroVAX operates NASTRAN so well that the only detectable difference in its operation compared to an 11/780 VAX is in the execution time. On the modest installation described here, the engineer has all of the tools he needs to do an excellent job of analysis. System configuration decisions, system sizing, preparation of the system disk, definition of user quotas, installation, monitoring of system errors, and operation policies are discussed. Author

**N87-27237*#** Naval Ship Research and Development Center, Bethesda, Md.
**CHECKPOINT AND RESTART PROCEDURES FOR SINGLE AND MULTI-STAGE STRUCTURAL MODEL ANALYSIS IN NASTRAN/COSMIC ON A CDC 176**
George H. Camp and Dennis J. Fallon *In* COSMIC, 15th NASTRAN Users' Colloquium Aug. 1987 p 88-97 (For primary document see N87-27231 21-39)
Avail: NTIS HC A14/MF A01; also available from COSMIC, Athens, Ga. 30602 CSCL 20K

The Underwater Explosions Research Division (UERD) of the David Taylor Naval Ship Research and Development Center makes extensive use of NASTRAN/COSMIC on a CDC 176 to evaluate the structural response of ship structures subjected to underwater explosion shock loadings in the time domain. As relatively new users, UERD engineers have experienced difficulties with the checkpoint/restart feature because of the vague instructions in the user manual. Working procedures for the application of the checkpoint/restart feature to the transient analysis using NASTRAN/COSMIC are illustrated. Author

**N87-27238*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**INTERACTIVE PLOTTING OF NASTRAN DATA ON MICROCOMPUTERS**
Robert L. Norton *In* COSMIC, 15th NASTRAN Users' Colloquium Aug. 1987 p 98-110 (For primary document see N87-27231 21-39)
Avail: NTIS HC A14/MF A01; also available from COSMIC, Athens, Ga. 30602 CSCL 20K

A microcomputer based program has been developed to aid in the development of NASTRAN models. The program reads in the complete NASTRAN data deck, produces a diagnostic print file, and then allows the user to view the model in an interactive mode. The program runs on a wide variety of hardware by making use of the Virtual Device Interface. Author

**N87-27239*#** Naval Ship Research and Development Center, Bethesda, Md. Numerical Structural Mechanics Branch.
**COMPUTER ANIMATION OF MODAL AND TRANSIENT VIBRATIONS**
Robert R. Lipman *In* COSMIC, 15th NASTRAN Users' Colloquium Aug. 1987 p 111-117 (For primary document see N87-27231 21-39)
Avail: NTIS HC A14/MF A01; also available from COSMIC, Athens, Ga. 30602 CSCL 20K

An interactive computer graphics processor is described that is capable of generating input to animate modal and transient vibrations of finite element models on an interactive graphics system. The results from NASTRAN can be postprocessed such that a three dimensional wire-frame picture, in perspective, of the finite element mesh is drawn on the graphics display. Modal vibrations of any mode shape or transient motions over any range of steps can be animated. The finite element mesh can be color-coded by any component of displacement. Viewing parameters and the rate of vibration of the finite element model can be interactively updated while the structure is vibrating. Author

**N87-27240*#** RPK Corp., Columbia, Md.
**BUBBLE VECTOR IN AUTOMATIC MERGING**
P. R. Pamidi and T. G. Butler (Butler Analyses, Towson, Md.) *In* COSMIC, 15th NASTRAN Users' Colloquium Aug. 1987 p 118-135 (For primary document see N87-27231 21-39)
Avail: NTIS HC A14/MF A01; also available from COSMIC, Athens, Ga. 30602 CSCL 20K

It is shown that it is within the capability of the DMAP language to build a set of vectors that can grow incrementally to be applied automatically and economically within a DMAP loop that serves to append sub-matrices that are generated within a loop to a core matrix. The method of constructing such vectors is explained. Author

**N87-27241*#** Butler Analyses, Towson, Md.
**MASS MODELING FOR BARS**
Thomas G. Butler *In* COSMIC, 15th NASTRAN Users' Colloquium Aug. 1987 p 136-165 (For primary document see N87-27231 21-39)
Avail: NTIS HC A14/MF A01; also available from COSMIC, Athens, Ga. 30602 CSCL 20K

Methods of modeling mass for bars are surveyed. A method for extending John Archer's concept of consistent mass beyond just translational inertia effects is included. Recommendations are given for various types of modeling situations. Author

**N87-27242*#** Dynamic Engineering, Inc., Newport News, Va.
**THE USE OF NASTRAN IN THE DESIGN OF WIND TUNNEL RESEARCH AIRCRAFT**
Michael Cooper *In* COSMIC, 15th NASTRAN Users' Colloquium

Aug. 1987 p 166-183 (For primary document see N87-27231 21-39)
Avail: NTIS HC A14/MF A01; also available from COSMIC, Athens, Ga. 30602 CSCL 20K

The relationship between NASTRAN and the wind tunnel model design process is discussed. Specific cases illustrating the use of NASTRAN for static, heat transfer, dynamic, and aeroelastic analyses are presented. Advantages and disadvantages of using NASTRAN are summarized. Author

**N87-27243*#** Naval Ship Research and Development Center, Bethesda, Md.
**APPLICATION OF NASTRAN/COSMIC IN THE ANALYSIS OF SHIP STRUCTURES TO UNDERWATER EXPLOSION SHOCK**
D. J. Fallon, F. A. Costanzo, R. T. Handleton, G. C. Camp, and D. C. Smith *In* COSMIC, 15th NASTRAN Users' Colloquium Aug. 1987 p 184-206 (For primary document see N87-27231 21-39)
Avail: NTIS HC A14/MF A01; also available from COSMIC, Athens, Ga. 30602 CSCL 20K

The application of NASTRAN/COSMIC in predicting the transient motion of ship structures to underwater, non-contact explosions is discussed. Examples illustrate the finite element models, mathematical formulations of loading functions and, where available, comparisons between analytical and experimental results. Author

**N87-27244*#** Texas Instruments, Inc., Austin.
**CALCULATION OF FORCES ON MAGNETIZED BODIES USING COSMIC NASTRAN**
John Sheerer *In* COSMIC, 15th NASTRAN Users' Colloquium Aug. 1987 p 207-213 (For primary document see N87-27231 21-39)
Avail: NTIS HC A14/MF A01; also available from COSMIC, Athens, Ga. 30602 CSCL 20K

The methods described may be used with a high degree of confidence for calculations of magnetic traction forces normal to a surface. In this circumstance all models agree, and test cases have resulted in theoretically correct results. It is shown that the tangential forces are in practice negligible. The surface pole method is preferable to the virtual work method because of the necessity for more than one NASTRAN run in the latter case, and because distributed forces are obtained. The derivation of local forces from the Maxwell stress method involves an undesirable degree of manipulation of the problem and produces a result in contradiction of the surface pole method. Author

**N87-27245*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**BUCKLING ANALYSIS OF THE QUADRIPOD STRUCTURE FOR THE NASA 70-METER ANTENNA**
Chian T. Chian *In* COSMIC, 15th NASTRAN Users' Colloquium Aug. 1987 p 214-221 (For primary document see N87-27231 21-39)
Avail: NTIS HC A14/MF A01; also available from COSMIC, Athens, Ga. 30602 CSCL 20K

As part of the effort to extend the diameter of three Deep Space Network large earth antennas from 64 meters to 70 meters, a slim profiled quadripod structure was designed to support a 7.7 meter diameter subreflector for the 70 meter antenna. The new quadripod design, which particularly emphasizes reduced radio frequency blockage, is achieved by means of a narrow cross sectional profile of the legs. Buckling analysis, using NASTRAN, was conducted in this study to verify the safety margin for the quadripod structural stability. Author

**N87-27246*#** NKF Engineering Associates, Inc., Vienna, Va.
**THEORETICAL ANALYSIS OF HVAC DUCT HANGER SYSTEMS**
R. D. Miller *In* COSMIC, 15th NASTRAN Users' Colloquium Aug. 1987 p 222-249 (For primary document see N87-27231 21-39)
Avail: NTIS HC A14/MF A01; also available from COSMIC, Athens, Ga. 30602 CSCL 20K

Several methods are presented which, together, may be used in the analysis of duct hanger systems over a wide range of frequencies. The finite element method (FEM) and component mode synthesis (CMS) method are used for low- to mid-frequency range computations and have been shown to yield reasonably close results. The statistical energy analysis (SEA) method yields predictions which agree with the CMS results for the 800 to 1000 Hz range provided that a sufficient number of modes participate. The CMS approach has been shown to yield valuable insight into the mid-frequency range of the analysis. It has been demonstrated that it is possible to conduct an analysis of a duct/hanger system in a cost-effective way for a wide frequency range, using several methods which overlap for several frequency bands. Author

**N87-27247*#** Naval Ship Research and Development Center, Bethesda, Md.
**COUPLED NASTRAN/BOUNDARY ELEMENT FORMULATION FOR ACOUSTIC SCATTERING**
Gordon C. Everstine, Francis M. Henderson, and Luise S. Schuetz (Naval Research Lab., Washington, D.C.) *In* COSMIC, 15th NASTRAN Users' Colloquium Aug. 1987 p 250-265 (For primary document see N87-27231 21-39)
Avail: NTIS HC A14/MF A01; also available from COSMIC, Athens, Ga. 30602 CSCL 20K

A coupled finite element/boundary element capability is described for calculating the sound pressure field scattered by an arbitrary submerged 3-D elastic structure. Structural and fluid impedances are calculated with no approximation other than discretization. The surface fluid pressures and normal velocities are first calculated by coupling a NASTRAN finite element model of the structure with a discretized form of the Helmholtz surface integral equation for the exterior field. Far field pressures are then evaluated from the surface solution using the Helmholtz exterior integral equation. The overall approach is illustrated and validated using a known analytic solution for scattering from submerged spherical shells. Author

**N87-27248*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**NASTRAN APPLICATION FOR THE PREDICTION OF AIRCRAFT INTERIOR NOISE** **c71**
Francesco Marulo and Todd B. Beyer *In* COSMIC, 15th NASTRAN Users' Colloquium Aug. 1987 p 266-285 (For primary document see N87-27231 21-39)
Avail: NTIS HC A14/MF A01; also available from COSMIC, Athens, Ga. 30602 CSCL 20K

The application of a structural-acoustic analogy within the NASTRAN finite element program for the prediction of aircraft interior noise is presented. Some refinements of the method, which reduce the amount of computation required for large, complex structures, are discussed. Also, further improvements are proposed and preliminary comparisons with structural and acoustic modal data obtained for a large, composite cylinder are presented. Author

**N87-27249*#** Naval Underwater Systems Center, New London, Conn.
**A STRUCTURAL ANALYSIS OF AN OCEAN GOING PATROL BOAT SUBJECTED TO PLANNING LOADS**
James H. Clark, Robert Lafreniere, Robert Stoodt, and John Wiedenheft *In* COSMIC, 15th NASTRAN Users' Colloquium Aug. 1987 p 286-306 (For primary document see N87-27231 21-39)
Avail: NTIS HC A14/MF A01; also available from COSMIC, Athens, Ga. 30602 CSCL 20K

A static structural analysis of an ocean going patrol vessel subjected to hydrodynamic planning loads is discussed. The analysis required the development of a detailed model that included hull plating, five structural bulkheads, longitudinal and transverse stiffners, and a coarse representation of the superstructure. The finite element model was developed from fabrication drawings using the Navy computer aided design system. Various stress and displacement contours are shown for the entire hull. Because

several critical areas appeared to be overstressed, these areas were remeshed for detail and are presented for completeness.
Author

**N87-27250#** Computational Mechanics Consultants, Austin, Tex.
**COMPUTATIONAL METHODS FOR NONLINEAR DYNAMIC PROBLEMS IN SOLID AND STRUCTURAL MECHANICS: PROGRESS IN THE THEORY AND MODELING OF CONTACT AND FRICTION Annual Technical Report, 1 Mar. 1986 - 1 Mar. 1987**
J. T. Oden 25 Mar. 1987 57 p
(Contract F49620-86-C-0051)
(AD-A180692; TR-87-02; AFOSR-87-0640TR) Avail: NTIS HC A04/MF A01 CSCL 20K

The theory and modeling of contact and friction on both rough dry surfaces and on lubricated surfaces is discussed. A summary of work on the quality of the numerical analysis of elastohydrodynamic lubrication problems is given. A complete mathematical foundation is established for these problems, new numerical methods are devised, adaptive finite elements schemes are constructed, and a variety of numerical solutions is obtained. A-priori estimates are derived, which are shown to give estimates of rates of convergence in agreement with numerical experiments. A summary of ongoing work and the development of new models of contact and friction on rough surfaces is given. A probabilistic model of rough dry surfaces is described, in which asperity heights are assumed to be randomly distributed over a surface. The effects of inter-molecular adhesion on contact friction are included. This approach allows one to focus on the problem of deformation of a typical asperity. In this work we assume the mechanical response of an asperity to be nonlinear viscoplastic, enabling one to model elastic, viscoelastic, plastic, and viscoplastic response as well as damage of rough surfaces in contact. Preliminary versions of these models are used to study the elasto-dynamic behavior and control of structural components subjected to frictional forces. Numerical results show that the models have excellent agreement with experimental data. GRA

**N87-27251#** Princeton Univ., N. J.
**EFFECT OF GAS BUBBLES ON THE PLASTIC ZONE AROUND A CRACK TIP**
Guido D. Dhondt and A. C. Eringen Apr. 1987 37 p
(Contract DAAL03-86-K-0019)
(AD-A181001; ARO-22967.3-EG) Avail: NTIS HC A03/MF A01 CSCL 18A

During the loading of a crack edge, dislocations are emitted from the crack tip forming a plastic zone. The presence of gas bubbles near the crack tip can change the plastic zone size and location drastically. A detailed study of the force field on an edge dislocation due to the crack load and gas bubbles allows for the determination of the plastic zone as a function of the inclination angle. The dislocation distribution along the plastic zone is found from force equilibrium considerations. Due to the presence of gas bubbles a shrinking and repulsion of the plastic zone from the crack tip is noticed. This process indicates the material embrittlement. The dislocation free zone (DFZ) near the crack tip grows. This embrittlement can become crucial in material design for fusion applications. GRA

**N87-27252#** Brown Univ., Providence, R. I. Div. of Engineering.
**ELASTIC-PLASTIC ANALYSIS OF CRACKS ON BIMATERIAL INTERFACES. PART 1: SMALL SCALE YIELDING**
C. F. Shih and R. J. Asaro Mar. 1987 59 p
(Contract N00014-87-K-0119)
(AD-A181005) Avail: NTIS HC A04/MF A01 CSCL 20K

Full field numerical solutions for a crack which lies along the interface of an elastic-plastic medium and rigid substrate are presented. The solutions are obtained using a small strain version of the j2 deformation theory with power law strain hardening. Loading resulting in only small scale yielding and fully plastic behavior will be presented. The oscillatory stresses on the bond line and overlapping of the crack faces, characteristic of small strain linear elasticity, are shown to be essentially precluded by material nonlinearity. In addition we find that, although the near tip fields do not appear to have a separable form as for the well known HRR fields in homogeneous media, they do bear interesting similarities to certain mixed mode HRR fields. Numerical procedures appropriate for solving a general class of interface crack problems are described. A description of a numerical method for extracting the mixed mode stress intensities for cracks at interfaces, and in homogeneous isotropic or anisotropic media, is included. GRA

**N87-27253#** Brown Univ., Providence, R. I. Div. of Engineering.
**AN EXPERIMENTAL STUDY OF THE FORMATION PROCESS OF ADIABATIC SHEAR BANDS IN A STRUCTURAL STEEL**
A. Marchand and J. Duffy Apr. 1987 65 p
(Contract N00014-85-K-0597; Grant NSF DMR-83-16893)
(AD-A181006) Avail: NTIS HC A04/MF A01 CSCL 11F

A series of experiments is described in which the local temperature and local strain are measured during the formation of an adiabatic shear band in a low alloy structural steel (HY-100). The specimen employed consists of a short thin-walled tube and the required rapid deformation rates are imposed by loading the specimen in a torsional Kolsky bar (split Hopkinson bar). The local temperature is determined by measuring the infrared radiation emanating at twelve neighboring points on the specimen's surface, including the shear band area. Indium-antimony elements are employed for this purpose to give the temperature history during deformation. In addition, high speed photographs are made of a grid pattern deposited on the specimen's surface, thus providing a measure of the strain distribution at various stages during shear band formation. By testing a number of specimens it is possible to form a picture of the developing strain localization process, of the temperature history within the forming shear band, and of the consequent loss in the load capacity of the steel. GRA

**N87-27254#** Chemical Research and Development Center, Aberdeen Proving Ground, Md.
**DESIGN METHODOLOGY FOR A LIGHTWEIGHT, RESONANT-FREE PLATEN FOR VIBRATION TESTING Special Publication, Jan. 1984 - Mar. 1985**
Louie J. Lipp Apr. 1987 45 p
(AD-A181159; CRDEC-SP-87014) Avail: NTIS HC A03/MF A01 CSCL 14B

Vibration testing, particularly when performed in reliability test chambers, is very costly. Discussed in this report are the equations for designing a resonant-free platen for holding several test specimens for simultaneous testing. The unique feature of this platen is that it is an inverted pyramid that has been truncated to mate with a shaker head. This design is less likely to have resonance problems and is significantly lighter than one of constant thickness. Specific points covered are: determination of the dimensions for a resonant-free platen, determination of the total weight of the platen, selection of a structurally damped material, and a computer program for performing all necessary calculations. GRA

**N87-27255#** Aeronautical Research Labs., Melbourne (Australia).
**A REVIEW OF AUSTRALIAN INVESTIGATIONS ON AERONAUTICAL FATIGUE DURING THE PERIOD APRIL 1985 TO MARCH 1987 Structures Technical Memorandum**
G. S. Jost, ed. Apr. 1987 65 p Presented at the 20th Conference of the International Committee on Aeronautical Fatigue, 8-9 Jun. 1987
(AD-A181313; ARL-STRUC-TM-457) Copyright Avail: NTIS HC A04/MF A01 CSCL 20K

The previous Australian ICAF review, referred to damage tolerance assessment work on the RAAF Mirage fleet. Since that time strain data from flight tests and ground calibrations have been analyzed and this has led to the conclusion that structural control points in the rear fuselage and front fuselage are not stressed sufficiently high to require detailed damage tolerance assessment. The Swiss fatigue test has been completed with the exception of the teardown inspection of some parts of the airframe.

These include the fin which is thought to contain a crack at the main spar root. Crack growth calculations for damage tolerance assessment have been concerned with control points in the wing and fuselage frame 26. The Wheeler crack growth model has been successfully validated against crack growth data from ARL tests on component simulation specimens, and also against data from cracks generated in the wing during the Swiss fatigue test. However attempts to validate the model against Swiss crack growth data from frame 26 were unsuccessful. Predicted crack growth rates from the model (using the best estimate of local strain response based on existing information) were much slower than those measured on test. For this reason the inspection intervals calculated by the model for frame 26 need careful interpretation. GRA

**N87-27256#** Dayton Univ., Ohio.
**EFFECT OF FREQUENCY ON FATIGUE CRACK GROWTH RATE OF INCONEL 718 AT HIGH TEMPERATURE Interim Report, Jan. 1984 - Jan. 1987**
N. E. Ashbaugh and Tusit Weerasooriya Jun. 1987 45 p
(Contract F33615-84-C-5051)
(AD-A181548; AFWAL-TR-87-4038) Avail: NTIS HC A03/MF A01 CSCL 11F

Fatigue crack growth was studied at 650 deg. C as a function of frequency for several ratios of minimum-to-maximum stress intensity, and for two values of maximum stress intensity factor. Crack lengths were monitored at low frequencies from compliance calculations based on crack mouth opening displacement measurements. At higher frequencies, crack length was measured using a d.c. electric potential system. It was found that fatigue crack growth rate can be characterized in three distinct frequency regions. These three regions represent fully cycle dependent, mixed, and fully time dependent crack growth behavior and each region can be modeled by a power law function. Observation of micro mechanisms support the existence of these three different regions of crack growth. GRA

**N87-27257#** University Coll. of North Wales, Bangor. School of Electronic Engineering Science.
**SHEAROGRAPHIC IMAGING SYSTEM Final Report, 16 Oct. 1984 - 16 Dec. 1986**
D. K. Das-Gupta 1 Jun. 1987 33 p
(Contract DAJA45-84-C-0042)
(AD-A181665; RVK-50) Avail: NTIS HC A03/MF A01 CSCL 20F

An optical shearing technique has been used to produce high quality strain contours of centrally loaded, or thermally stressed and clamped plates. An analysis of strain from these fringes provides good agreement between experimental and theoretical values. It has also been shown that this technique is compatible with infrared thermographs in the detection of delamination in a composite laminated plate. The above work was followed by developing an on line electronic speckle shearing technique in which the optical camera was replaced with electronic camera and its associated data storage and analysis and display system. This latter method shows good promise. However, it requires further work and equipments for better image process facilities to improve the fringe resolutions. Author (GRA)

**N87-27258#** Army Lab. Command, Watertown, Mass. Material Technology Lab.
**A SEMIAUTOMATED SYSTEM FOR MOIRE STRAIN ANALYSIS Final Report**
Alan H. Katz Mar. 1987 21 p
(AD-A181692; MTL-TR-87-14) Avail: NTIS HC A02/MF A01 CSCL 20K

A method for analyzing Moire fringe photographs without acquiring point by point data manually is described. A computer controlled video digitizer is used to acquire video intensity data for up to 1024 x 1024 pixels per photograph. Software was developed to acquire the data and store it locally to the digitizer's computer. Data reduction and analysis is performed on a host minicomputer. Software for this host was developed to upload all the data, perform error checking and subsequently perform the reduction and analysis. The data analysis is performed using a finite elements global smoothing technique. This method allows the displacements to be input to the analysis and the strains determined. Results may be plotted as contours of strain or slices may be taken at any locations in any direction. GRA

**N87-27259#** Virginia Polytechnic Inst. and State Univ., Blacksburg.
**THE EFFECT OF NONLINEARITIES ON FLEXIBLE STRUCTURES Annual Report, 30 Apr. 1986 - 30 Apr. 1987**
A. H. Nayfeh and D. T. Mook 30 Apr. 1987 9 p
(Grant AF-AFOSR-0090-86)
(AD-A181735; AFOSR-87-0712TR) Avail: NTIS HC A02/MF A01 CSCL 20K

Experimental-theoretical studies have been conducted on the influence of nonlinearities on flexible structures in the presence of either an external or a parametric excitation. A single-degree-of-freedom system with quadratic and cubic nonlinearities under the influence of a harmonic parametric excitation was studied using the method of multiple scales and digital-and analog-computer simulations. A global bifurcation diagram was obtained showing the different possible attractors (point, limit cycle, chaotic attractors). For small excitation amplitudes, the perturbation results are in excellent agreement with the digital- and analog-computer simulations. For moderate to large excitation amplitudes, the accuracy of the perturbation solution is questionable and only digital- and analog-computer simulations were used. The results are in full agreement. GRA

**N87-27260*#** Old Dominion Univ., Norfolk, Va. Dept. of Civil Engineering.
**SUBSTRUCTURE ANALYSIS USING NICE/SPAR AND APPLICATIONS OF FORCE TO LINEAR AND NONLINEAR STRUCTURES Progress Report, period ending 30 Jun. 1987**
Zia Razzaq, Venkatesh Prasad, Siva Prasad Darbhamulla, Ravinder Bhati, and Cai Lin Aug. 1987 129 p
(Grant NAG1-438)
(NASA-CR-180317; NAS 1.26:180317) Avail: NTIS HC A07/MF A01 CSCL 20K

Parallel computing studies are presented for a variety of structural analysis problems. Included are the substructure planar analysis of rectangular panels with and without a hole, the static analysis of space mast, using NICE/SPAR and FORCE, and substructure analysis of plane rigid-jointed frames using FORCE. The computations are carried out on the Flex/32 MultiComputer using one to eighteen processors. The NICE/SPAR runstream samples are documented for the panel problem. For the substructure analysis of plane frames, a computer program is developed to demonstrate the effectiveness of a substructuring technique when FORCE is enforced. Ongoing research activities for an elasto-plastic stability analysis problem using FORCE, and stability analysis of the focus problem using NICE/SPAR are briefly summarized. Speedup curves for the panel, the mast, and the frame problems provide a basic understanding of the effectiveness of parallel computing procedures utilized or developed, within the domain of the parameters considered. Although the speedup curves obtained exhibit various levels of computational efficiency, they clearly demonstrate the excellent promise which parallel computing holds for the structural analysis problem. Source code is given for the elasto-plastic stability problem and the FORCE program. Author

**N87-27261#** Oak Ridge Gaseous Diffusion Plant, Tenn.
**FORD AEROSPACE HIGH-G TEST SERIES 2 AND 3**
D. L. Beshears Mar. 1987 75 p
(Contract DE-AC05-84OT-21400)
(DE87-008355; K/ETAC-7) Avail: NTIS HC A04/MF A01

A series of tests is being conducted on electronic and optical components and assemblies to determine how well they operate after periods of constant high acceleration. This testing is being performed for the Ford Aerospace and Communications Corporation in support of the Air Force Space and Technology

Center Sagittar Program. This final report documents the second and third series of tests which consisted of 47 test runs. The tests included the evaluation of some packaging techniques in an effort to extend the load capacity of a Panasonic lithium battery. Other tests conducted in Series 2 consisted of accelerating two receiver units (one with a gallium arsenide lens and the other with a zinc sulfide lens) to various G levels up to 120,281 G's. The qualification target for each of these units is 120,000 G's. In Test Series 3, it was possible to further extend the Panasonic lithium battery life by not only encapsulating the battery in Castolite plastic, but also enclosing the entire assembly in an aluminum housing. The other components tested in Test Series 3 included two receiver units (one with a germanium lens and the other a 19-mm Kodak zinc sulfide lens), a 40-mm hybrid controller, a zinc sulfide lens assembly, an Altus lithium battery, a germanium filter, and two detectors. The qualification target for the 2 batteries and the 40-mm hybrid controller is 120,000 G's, while the qualification target for each of the other components tested in Series 3 is 140,000 G's. DOE

**N87-27262#** Lawrence Livermore National Lab., Calif.
**CONSTITUTIVE MODELS USED IN COMPUTER SIMULATION OF TIME-RESOLVED, SHOCK-WAVE DATA**
D. J. Steinberg Apr. 1987 9 p Presented at IMPACT '87, Bremen, West Germany, 18 May 1987
(Contract W-7405-eng-48)
(DE87-008471; UCRL-93703-Rev-1; CONF-8705109-3-Rev-1)
Avail: NTIS HC A02/MF A01

Some 15 years ago, a constitutive model for metals applicable at high-strain rates was developed. When this model was first described in the literature, very little time-resolved, shock-wave data were available for peak loading stresses in excess of 10 GPa. This problem has since been rectified. The purpose here is to show how well our model can predict these new data. Experimental and calculational velocity-time shock loading and release profiles are compared for Be, U, Ta, Cu, and 1100-O Al. DOE

**N87-27263#** Allied Bendix Aerospace, Kansas City, Mo.
**FEASIBILITY STUDY FOR USING LIQUID SPRINGS TO PRODUCE MECHANICAL SHOCK PULSES**
L. F. Thorne Apr. 1987 35 p
(Contract DE-AC04-76DP-00613)
(DE87-009099; BDX-613-3748) Avail: NTIS HC A03/MF A01

Equations have been developed to predict the performance of liquid springs when used on shock machines to perform low amplitude, long duration shock pulses. Graphs prepared from the equations show the increase in equipment capability that is possible for six candidate machines equipped with liquid spring devices. Programs have been written for a programmable calculator to provide an efficient means of determining the design details for liquid springs with which specified tests can be performed on selected machines. Two 20,000 psi pressure cylinders have been purchased as the basic element for fabricating two liquid spring devices which will be used to study liquid spring performance and to verify design theory. DOE

**N87-27264#** Sandia National Labs., Albuquerque, N. Mex.
**KEY CURVE APPROACH TO STATIC AND DYNAMIC FRACTURE TOUGHNESS MEASUREMENT**
R. Salzbrenner May 1987 35 p
(Contract DE-AC04-76DP-00789)
(DE87-010536; SAND-87-0795) Avail: NTIS HC A03/MF A01

The elastic-plastic fracture toughness of fully ferritic ductile cast iron has been determined at two different loading rates by employing the key curve analysis method. The key curve results are directly compared with values obtained from the multiple specimen method at each rate. Further, the measurement of crack growth resistance by the two methods is compared. The fracture toughness is (within experimental error) unchanged by varying displacement rate from static (5.0 x 10 to the -6 m/sec) to 1.0 x 10 to the -2 m/sec. The slope of the crack growth resistance curve as measured by the key curve method is approximately twice that measured by the multiple specimen technique. DOE

**N87-27265*#** Florida Atlantic Univ., Boca Raton. Center for Acoustics and Vibration.
**EXTENSION OF VIBRATIONAL POWER FLOW TECHNIQUES TO TWO-DIMENSIONAL STRUCTURES Annual Report No. 1**
J. M. Cuschieri Aug. 1987 29 p
(Grant NAG1-685)
(NASA-CR-180282; NAS 1.26:180282) Avail: NTIS HC A03/MF A01 CSCL 20K

In the analysis of the vibration response and structure-borne vibration transmission between elements of a complex structure, statistical energy analysis (SEA) or Finite Element Analysis (FEA) are generally used. However, an alternative method is using vibrational power flow techniques which can be especially useful in the mid- frequencies between the optimum frequency regimes for FEA and SEA. Power flow analysis has in general been used on one-dimensional beam-like structures or between structures with point joints. In this paper, the power flow technique is extended to two-dimensional plate like structures joined along a common edge without frequency or spatial averaging the results, such that the resonant response of the structure is determined. The power flow results are compared to results obtained using FEA at low frequencies and SEA at high frequencies. The agreement with FEA results is good but the power flow technique has an improved computational efficiency. Compared to the SEA results the power flow results show a closer representation of the actual response of the structure. Author

**N87-27266#** Washington Univ., Seattle. Dept. of Mechanical Engineering.
**THEORETICAL AND EXPERIMENTAL INVESTIGATIONS ON PROPAGATING DUCTILE CRACKS IN PIPELINES Final Report**
A. S. Kobayashi, A. F. Emery, and W. J. Love Sep. 1986 179 p
(Contract DTRS56-83-C-00009)
(PB87-182846; DOT/OST/P34-87/057) Avail: NTIS HC A09/MF A01 CSCL 20K

The objective of the research was to analytically and experimentally study the dynamic crack propagation of an axial crack in a high-pressure pipeline. An improved split-ring model of dynamic axial crack propagation, which models rapid crack extension and crack arrest, was developed. The experimental data obtained through small-scale pipe rupture studies and a simplified theoretical model analysis provided the necessary insight into the mechanics governing dynamic axial crack propagation in pressurized pipes. These findings are being incorporated into an improved split-ring model of axial pipe rupture which should become a practical analytical tool in pipeline design. GRA

**N87-27267*#** Pratt and Whitney Aircraft, East Hartford, Conn. Engineering Div.
**3-D INELASTIC ANALYSIS METHODS FOR HOT SECTION COMPONENTS. VOLUME 2: ADVANCED SPECIAL FUNCTIONS MODELS Annual Status Report No. 3**
R. B. Wilson and P. K. Banerjee Aug. 1987 87 p
(Contract NAS3-23697)
(NASA-CR-179517; NAS 1.26:179517; PWA-5940-46-Vol-2)
Avail: NTIS HC A05/MF A01 CSCL 20K

This Annual Status Report presents the results of work performed during the third year of the 3-D Inelastic Analysis Methods for Hot Sections Components program (NASA Contract NAS3-23697). The objective of the program is to produce a series of computer codes that permit more accurate and efficient three-dimensional analyses of selected hot section components, i.e., combustor liners, turbine blades, and turbine vanes. The computer codes embody a progression of mathematical models and are streamlined to take advantage of geometrical features, loading conditions, and forms of material response that distinguish each group of selected components. Author

**N87-27268*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**SINDA-NASTRAN INTERFACING PROGRAM THEORETICAL DESCRIPTION AND USER'S MANUAL**
Steven R. Winegar Aug. 1987 31 p
(NASA-TM-100158; E-3720; NAS 1.15:100158) Avail: NTIS HC A03/MF A01 CSCL 20K

The task of converting SINDA finite difference thermal model temperature results into NASTRAN finite element model thermal loads can be very labor intensive if there is not one node-to-one element, or systematic node-to-element. correlation between models. This paper describes the SINDA-NASTRAN Interfacing Program (SNIP), a FORTRAN computer code that generates NASTRAN structural model thermal load cards given by SINDA (or similar thermal model) temperature results and thermal model geometric data. SNIP generates NASTRAN thermal load cards for NASTRAN plate, shell, bar, and beam elements. The paper describes the interfacing procedures used by SNIP, and discusses set-up and operation of the program. Sample cases are included to demonstrate use of the program and show its performance under a variety of conditions. SNIP can provide structural model thermal loads that accurately reflect thermal model results while reducing the time required to interface thermal and structural models when compared to other methods. Author

**N87-27269*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**FRACTURE MECHANICS CONCEPTS IN RELIABILITY ANALYSIS OF MONOLITHIC CERAMICS**
Jane M. Manderscheid and John P. Gyekenyesi Aug. 1987 16 p Presented at the Testing High Performance Ceramics, Boston, Mass., 25-27 Aug. 1987; sponsored in part by American Ceramic Society, and the American Society for Nondestructive Testing.
(NASA-TM-100174; E-3743; NAS 1.15:100174) Avail: NTIS HC A02/MF A01 CSCL 20K

Basic design concepts for high-performance, monolithic ceramic structural components are addressed. The design of brittle ceramics differs from that of ductile metals because of the inability of ceramic materials to redistribute high local stresses caused by inherent flaws. Random flaw size and orientation requires that a probabilistic analysis be performed in order to determine component reliability. The current trend in probabilistic analysis is to combine linear elastic fracture mechanics concepts with the two parameter Weibull distribution function to predict component reliability under multiaxial stress states. Nondestructive evaluation supports this analytical effort by supplying data during verification testing. It can also help to determine statistical parameters which describe the material strength variation, in particular the material threshold strength (the third Weibull parameter), which in the past was often taken as zero for simplicity. Author

**N87-27270*#** Washington Univ., St. Louis, Mo. Center for Computational Mechanics.
**HIERARCHIC PLATE AND SHELL MODELS BASED ON SUBp-EXTENSION**
Barna A. Scabo and Glenn J. Sahrmann Jul. 1987 43 p
(Grant NAG1-639)
(NASA-CR-181232; NAS 1.26:181232; WU/CCM-87/5) Avail: NTIS HC A03/MF A01 CSCL 20K

This paper is concerned with formulations of finite element models for beams, arches, plates and shells based on the principle of virtual work. The focus is on computer implementation of hierarchic sequences of finite element models suitable for numerical solution of a large variety of practical problems which may concurrently contain thin and thick plates and shells, stiffeners, and regions where three dimensional representation is required. The approximate solutions corresponding to the hierarchic sequence of models converge to the exact solution of the fully three dimensional model. The stopping criterion is based on (1) estimation of the relative error in energy norm; (2) equilibrium tests; and, (3) observation of the convergence of quantities of interest. Author

**N87-27271#** Aeronautical Research Inst. of Sweden, Stockholm. Structures Dept.
**STRESS INTENSITY FACTOR EQUATIONS FOR SINGLE CRACKS IN ATTACHMENT LUGS**
Bjoern Palmberg Dec. 1986 99 p
(Contract FMV-FFL-82250-85-282-24-001)
(FFA-TN-1986-75; ETN-87-90072) Avail: NTIS HC A05/MF A01

A stress intensity factor equation for a single corner crack in an attachment lug is developed. Stress intensity factor equations are reviewed or developed. Stress intensity factor equations for straight and tapered attachment lugs having a single through thickness crack are obtained. ESA

**N87-27272#** Aeronautical Research Inst. of Sweden, Stockholm. Structures Dept.
**STRESS INTENSITY FACTOR EQUATIONS FOR A CORNER CRACK LOCATED AT AN OPEN HOLE AND SUBJECTED TO DIFFERENT CRACK SURFACE PRESSURE DISTRIBUTIONS**
Bjoern Palmberg 1986 41 p
(Contract FMV-FFL-82250-85-282-24-001)
(FFA-TN-1986-80; ETN-87-90073) Avail: NTIS HC A03/MF A01

A stress intensity factor equation for a single corner crack at an open hole, subjected to four different crack surface pressure distributions was developed. An equation for the same geometry, a plate of finite dimensions with a circular hole, but loaded with a uniform, uniaxial stress was also developed. The equations take into account the finite dimensions of the plate and allow for an eccentrically located hole. The equations produce conservative estimates when compared to a finite element solution. Stress intensity factors for crack surface pressure distributions can be used to estimate other stress intensity factors by applying the principle of superposition and the stress distribution along the prospective crack path in the uncracked body. This technique was used to check the performance of the four stress intensity factor equations representing the different basic crack surface pressure distributions. The result shows that the third order polynomial stress distribution, which can be accomplished with the four basic solutions, is not sufficient if large crack length intervals have to be considered. ESA

**N87-27273#** Aeronautical Research Inst. of Sweden, Stockholm. Structures Dept.
**INFLUENCE OF RESIDUAL STRESS FIELDS ON FATIGUE CRACK PROPAGATION**
Anders F. Blom Feb. 1987 42 p Presented at the Conference on Residual Stresses: Origin and Influence on Material Behavior, Sunne, Sweden, 30 Mar. - 2 Apr. 1987
(Contract STEV-506-266-1)
(FFA-TN-1987-10; ETN-87-90074) Avail: NTIS HC A03/MF A01

Means to introduce beneficial compressive stress fields for fatigue cracks, and measurement techniques to estimate the residual stress distributions are discussed. It is shown how to derive stress intensity factors for cracks in residual stress fields by superposition techniques. The redistribution of residual stress fields during fatigue crack growth is treated, emphasizing load history effects encountered in spectrum loading. Fatigue crack propagation at weldments in a wind energy turbine is analyzed. ESA

**N87-27274#** Royal Aircraft Establishment, Farnborough (England).
**MEASUREMENTS OF THE OUT-OF-PLANE DISPLACEMENT OF AN AXIALLY LOADED CRACKED METAL SHEET WITH A CFRP REPAIR PATCH**
R. M. J. Kemp Apr. 1986 24 p
(RAE-TM-MAT/STR-1074; BR100006; ETN-87-90089) Copyright Avail: NTIS HC A02/MF A01

An adhesively bonded CFRP repair patch situated centrally on one face of a 1.6 mm thick sheet test piece of aluminum alloy 7475-T761 containing a central fatigue crack caused an

out-of-plane displacement when the test piece was loaded in tension normal to the crack length. Out-of-plane displacements for crack lengths = 75 and 94 mm were measured. The magnitude of the displacement depends on crack length and is a nonlinear function of applied load. A greater displacement per load increment occurs at low loads and there is a tendency towards a limiting value at high loads. A moire shadow technique was used to measure displacements and the results agree well with dial gage measurements. Ultrasonic C-scan images reveal an adhesive debond region near the crack line at the center of a crack of length 94 mm. This debond is thought to be the reason for a disparity observed between displacement measurements on the patched and unpatched surfaces of the test piece. ESA

**N87-27275#** Sheffield Univ. (England). Dept. of Control Engineering.
**ESTIMATING HIGHER ORDER SPECTRA**
S. A. Billings and K. M. Tsang Oct. 1986 8 p
(RR-303; ETN-87-90099) Avail: NTIS HC A02/MF A01

Parametric algorithms for estimating the frequency response for linear systems and generalized frequency response functions for nonlinear systems are described. By estimating the coefficients in a nonlinear autoregressive moving average model with exogenous inputs, representation of the nonlinear system by any order of generalized transfer function can be computed directly. The evolution of the linear frequency response as a function of input operating point and many other properties can also be readily computed to aid the interpretation of the influence of the nonlinearities on the system frequency content. The algorithms are easy to apply, largely insensitive to measurement noise, and provide estimates that are often better than those using fast Fourier transformation/windowing methods. The nonlinear algorithm permits the estimate of any order of generalized transfer function from short data record lengths. ESA

**N87-27276#** Sheffield Univ. (England). Dept. of Control Engineering.
**A GENERALIZED FREQUENCY RESPONSE FOR NONLINEAR SYSTEMS**
S. P. Banks and B. Chanane Feb. 1987 25 p
(RR-310; ETN-87-90100) Avail: NTIS HC A02/MF A01

A frequency response for a nonlinear system in terms of the response of the system to a set of standard inputs which form a basis of L sq (0, infinity) is introduced. The theory is illustrated in the linear, bilinear, and general nonlinear cases. A realization theory is presented in terms of the multidimensional Laplace transform. The method may be developed in a variety of ways, particularly in the design of nonlinear filters. ESA

**N87-27277** CIAD, Zoetermeer (Netherlands).
**COMPUTATIONAL FRACTURE MECHANICS IN THE NETHERLANDS Final Report**
Jun. 1986 185 p
(ISBN-90-6818-024-X; ETN-87-90150) Copyright Avail: Issuing Activity

Calculation of fracture mechanics parameters; three dimensional crack tip parameters; crack growth modeling under monotonic loading; fatigue crack growth models; fatigue life prediction for welded joints in steel structures; a data base of stress intensity factors; and software packages for fracture mechanics are discussed. ESA

**N87-27278#** Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
**DAMPED NONLINEAR VIBRATIONS OF IMPERFECT THIN-WALLED CYLINDRICAL SHELLS**
D. K. Liu and J. Arbocz Oct. 1986 51 p
(VTH-LR-462; B8707440; ETN-87-90207) Avail: NTIS HC A04/MF A01

The damped nonlinear vibrations of thin-walled cylindrical shells with initial geometric imperfections are studied using Donnel type nonlinear shallow-shell equations in which the appropriate damping and inertial terms are introduced. Results indicate that the initial geometric imperfections and the magnitude of damping have significant influences on the nonlinear vibration behavior of the shells. The results provide qualitatively satisfactory explanations of experimental findings. ESA

**N87-27279#** Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
**INFLUENCE OF INITIAL GEOMETRIC IMPERFECTIONS ON NONLINEAR VIBRATIONS OF THIN CIRCULAR CYLINDER SHELLS**
D. K. Liu and J. Arbocz Feb. 1985 40 p
(VTH-LR-467; B8707442; ETN-87-90208) Avail: NTIS HC A03/MF A01

The nonlinear vibrations of thin walled cylindrical shells with initial geometric imperfections are studied using Donnell type nonlinear shallow-shell equations in which the appropriate damping and inertial terms are introduced. The initial geometric imperfections are modeled with an axisymmetric and an asymmetric trigonometric function. The simply-supported boundary conditions and the circumferential periodicity condition are satisfied. Two vibration modes are assumed though only one of them is directly excited. Galerkin's procedure is used to obtain two coupled nonlinear differential equations for the modal amplitudes. The approximate frequency-amplitude relationships for various initial imperfections, dampings, and excitations are calculated from these two equations using the method of averaging. Results indicate that the initial geometric imperfections and the amount of damping have quite strong effects on the nonlinear vibration of the shells. ESA

**N87-27280#** Technische Hogeschool, Delft (Netherlands). Dept. of Aerospace Engineering.
**INVESTIGATION ON FATIGUE CRACK GROWTH IN FIBER ADHESIVE BOND LINES**
M. L. C. E. Verbruggen Oct. 1985 55 p Sponsored by the Netherlands Foundation for Technical Research
(VTH-LR-478; B8707451; ETN-87-90217) Avail: NTIS HC A04/MF A01

Tension mode fatigue tests on a width tapered double cantilever beam (WTDCB) consisting of two aluminum adherends bonded together with an interfacial layer (adhesive or prepreg) were performed in laboratory air and distilled water. Results show that the WTDCB can be used to examine the fatigue crack growth rate in an adhesive or prepreg. For the same set of fatigue parameters the aramid prepreg shows much higher crack growth rates than the adhesive. Distilled water exposure has a detrimental effect on the fatigue behavior of prepreg and adhesive, more pronounced for the prepreg. Load tests prove that the crack growth rates observed in the fatigue experiments are the result of a fatigue mechanism (and not of a quasi-static phenomenon). ESA

**N87-27062#** FractuResearch, Inc., Galena, Ohio.
**FRACTURE ANALYSIS: A REVIEW**
D. Broek *In* Vibration Inst., The Shock and Vibration Digest, volume 18, no. 12 Dec. 1986 p 13-22 (For primary document see N87-27060 21-31)
Avail: NTIS HC A08/MF A01

# 42 GEOSCIENCES (GENERAL)

**N87-27281#** Joint Publications Research Service, Arlington, Va.
**USSR REPORT: EARTH SCIENCES**
4 Dec. 1986 77 p Transl. into ENGLISH from various Russian articles
(JPRS-UES-86-008) Avail: NTIS HC A05/MF A01

Topics addressed include: meteorology, oceanography; terrestrial geophysics; atmospheric physics; and Arctic and Anarctic research. For individual titles, see N87-27282 through N87-27306.

**N87-27282#** Joint Publications Research Service, Arlington, Va.
**SYSTEMS OF COUPLED GYROSTATS IN PROBLEMS IN GEOPHYSICAL HYDRODYNAMICS Abstract Only** **c43**

A. B. Glukhovskiy *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 1 Transl. into ENGLISH from Izvestiya Akademii Nauk SSSR: Fizika Atmosfery i Okeana (Moscow, USSR), v. 22, no. 7, Jul. 1986 p 701-711 Original language document was announced in IAA as A87-15232 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

The structure of dynamical systems which arise in the use of the Galerkin method in geophysical hydrodynamics problems is studied. Superpositions of three mode systems that have a simple hydrodynamical interpretation and are described by the Volterra equations of gyrostat motion, are examined. Consideration is given to the two-layer quasi-geostrophic general atmospheric circulation model, the double-diffusion convection model, and chains of Lorenz models which appear in Rayleigh-Benard problems. IAA

**N87-27283#** Joint Publications Research Service, Arlington, Va.
**BOUNDARY VALUE PROBLEM FOR SEA SURFACE TOPOGRAPHY IN SEA CURRENT MODELS Abstract Only** **c48**
Yu. L. Demin and R. A. Ibrayev *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 17-18 Transl. into ENGLISH from Izvestiya Akademii Nauk SSSR: Fizika Atmosfery i Okeana (Moscow, USSR), v. 22, no. 7, Jul. 1986 p 757-764 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

A formulation of the boundary value problem for sea surface topography is proposed. Both the traditional and proposed approaches are examined in the example of a model of equatorial currents. The model used includes primitive equations of motion, the hydrostatics equation and the continuity equation, as well as the boundary value problem for the ocean surface. The formulation is in the form of a Neumann problem, which has a number of advantages over the traditional approach. For example, computation of the level at the basin boundary is not required. Unlike problems for the integral stream function, the problem can be solved identically in both singly and multiply connected regions without complication of the algorithm or increase in the volume of computations. The solubility condition amd computation method are fully described. The method was used in computing currents in the equatorial Atlantic. The same model was employed by Yu. L. Demin, but the Neuman, not the Dirichlet problem was solved. The longitudinal grid interval was 1 deg, the latitudinal interval varied from 1 to 0.25 deg; the 15 horizons used were from the surface to 5,000 m. An implicit difference scheme was used with the approximation of nonlinear terms by directed differences. In each fixed time interval the solution of the difference equations was found by the upper relaxation method. The results are given in several figures. Comparisons with solution by the Dirichlet method revealed the great superiority of the new approach. Author

**N87-27284#** Joint Publications Research Service, Arlington, Va.
**MODEL OF WORLD OCEAN CLIMATE Abstract Only** **c47**
M. Ya. Verbitskiy and D. V. Chalikov *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 18 Transl. into ENGLISH from Okeanologiya (Moscow, USSR), v. 26, no. 3, May - Jun. 1986 p 357-364 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

The configuration of the oceanic basins plays a decisive role in the formation of planetary climate. The climatic model of the ocean proposed earlier by the authors was improved by the incorporation of a simulation of real planetary morphology. This model of the world ocean represents the three main oceans and the Arctic and Antarctic Oceans connected to them; the three main oceans have different angular widths but a constant depth. This idealized distribution of land and sea gives an entirely satisfactory approximation of the latitudinal distribution of continental land masses. Many features of global circulation of oceanic waters are represented. The model occupies an intermediate position in the family of models of oceanic climate. In detail it is superior to all approaches used earlier in the simple climatic models. Although it does not reproduce the three-dimensional structure of geophysical fields, in an idealized form it gives the fundamental elements of oceanic circulation and takes the geography of the ocean into account. The model can be used in reproducing the long-period evolution of climate within the framework of the three-component ocean-atmosphere-ice system. Author

**N87-27285#** Joint Publications Research Service, Arlington, Va.
**REACTION OF OCEAN-ATMOSPHERE SYSTEM TO DOUBLING OF ATMOSPHERIC CO2 CONTENT AND ITS SEASONAL VARIABILITY Abstract Only** **c45**
B. A. Kagan, V. A. Ryabchenko, and A. S. Safray *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 19 Transl. into ENGLISH from Okeanologiya (Moscow, USSR), v. 26, no. 3, May - Jun. 1986 p 365-375 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

The seasonal variability of reaction of the ocean-atmosphere system to a doubling of the content of atmospheric CO2 is evaluated. The point of departure is the thermodynamic model of seasonal evolution of the ocean-atmosphere system proposed by the authors in 1983. Two numerical experiments were carried out, in one of which the CO2 concentration was assumed equal to its preindustrial level, whereas twice this level was used in the second. The results of these elaborate calculations are summarized in two lengthy tables. It is shown that the deviations of surface temperature in the high and low altitudes would not differ greatly from one another due to the damping influence of the ocean. Quantitative estimates are given illustrating the important role of the ocean in response to the climatic system to change in external parameters. With direct allowance for the effects of heat transfer in the ocean the mean annual increase in temperature of the atmospheric surface layer caused by a doubling of the CO2 content for the Northern Hemisphere would be 0.97 K. In limiting cases it would be 2.07 and 0.16 K. Three-dimensional models of general circulation of the atmosphere, by comparison, give 2.9 and 3.0 K in the first case and 0.2 and 0.16 K in the second. Author

**N87-27286#** Joint Publications Research Service, Arlington, Va.
**PREDICTION OF SYNOPTIC MOVEMENTS IN POLYMODE REGION USING BAROTROPIC MODEL Abstract Only** **c48**
V. M. Kamenkovich, Yu. M. Grachev, and B. V. Kharkov *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 19-20 Transl. into ENGLISH from Okeanologiya (Moscow, USSR), v. 26, no. 3, May - Jun. 1986 p 376-381 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

A numerical barotropic model for predicting synoptic eddies in the open ocean was developed. The model was tested by analyzing the results of predictions of the field of synoptic eddies in the region of the POLYMODE experiment for the period 20 April to 20 May 1978 using the observed initial field and boundary values. The stream function fields at the horizons 100, 400, 700, and 1,400 m were used; the results of predictions for the first three of these horizons are given. The error in prediction at all horizons varies with time; the maxima and minima of such variations at different horizons are somewhat displaced relative to one another. The stream function fields computer for the 700 m horizons for 5, 15, and 25 days in advance are cited as an example and compared with the observed fields. The analyzed areas contained three well-defined eddy formations. Their actual and predicted evolution was compared. Two of these were predicted very precisely, whereas the third was predicted somewhat less successfully. The results of computations for the 100 and 400 m horizons were much the same as for the 700 m horizon. Computations for the 1,400 m level were not really successful. The results of the experiments indicate the possibility of barotropic predictions for individual horizons for times of about three weeks. Author

**N87-27287#** Joint Publications Research Service, Arlington, Va.
**QUASIGEOSTROPHIC THREE-LAYER MODEL OF HYDRODYNAMIC INSTABILITY OF CURRENTS FOR INVESTIGATING EDDY FORMATION CONDITIONS IN WORLD OCEAN Abstract Only** **c48**

A. S. Blatov, N. S. Rapilbekova, and V. I. Ulyanova *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 21 Transl. into ENGLISH from Okeanologiya (Moscow, USSR), v. 26, no. 3, May - Jun. 1986 p 389-394 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

A linear model of stability of a three-layer large-scale current with weak transverse velocity shear, as is characteristic for the North Trades Current in the Atlantic Ocean, was used in studying the joint influence of the vertical distributions of density and velocity in the ocean. Stability diagrams were constructed for a velocity profile simulating conditions in the open part of the ocean. A system of equations was derived which correctly represents the processes involved in the generation of unstable wave disturbances. The parameters of such wave disturbances are evaluated for the Poligon-70 region. An analysis of observations of currents and the hydrological structure of waters during the Poligon-70 period made it possible to estimate the predominant period of synoptic disturbances T is approximately 100 days, a length of wave disturbances wavelength approximately 480 km and the components of phase velocity of propagation of these disturbances c sub x = -5.4 cm/s and c sub y = -1.2 cm/s, giving an estimate of absolute phase velocity of 5.5 cm/s. These and other data clearly suggest that the observed unstable wave disturbances are in actuality baroclinic Rossby waves. It appears that the mean climatic hydrological structure of waters in this region did not have adequate reserves of available potential energy for baroclinic instability processes to be able to generate synoptic eddies. Author

**N87-27288#** Joint Publications Research Service, Arlington, Va.
**SPATIAL VARIABILITY OF THERMAL STRUCTURE OF OCEAN ACTIVE LAYER DURING PASSAGE OF SYNOPTIC EDDIES Abstract Only** **c48**
B. N. Filyushkin *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 22 Transl. into ENGLISH from Okeanologiya (Moscow, USSR), v. 26, no. 3, May - Jun. 1986 p 395-401 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

Maps of the spatial variability of the principal characteristics of the active layer of the ocean were plotted. The data used were from temperature surveys of the region of the POLYMODE experiment. For example, in a period of a weakly expressed seasonal thermocline, when the vertical temperature gradients are small, the topography of H sub 0 thickness of the upper quasihomogeneous layer poorly reflects the dynamic picture of the region. When there are great vertical temperature gradients and even a small thickness of the upper quasihomogeneous layer, the entire layer of the seasonal thermocline is usually subject to the effect of currents generated by passing eddies. The H sub low value at all seasons of the year therefore better reflects the dynamics of waters in the region. The thickness of the seasonal thermocline is a useful parameter because with the upwelling of waters at the center of a cyclone its thickness is always less than during the subsidence of waters at the center of an anticyclone. The thickness of the seasonal thermocline in a cyclone varies from 60 to 100 m, but in an anticylcone from 100 to 160 m, which makes possible approximate identification of the position and type of synoptic eddies. It is shown that analysis of thermal structure of the active layer of the ocean reveals a definite evolution of its parameters during the passage of eddies which has a definite correlation with instrumental measurements of currents made at the same time. Author

**N87-27289#** Joint Publications Research Service, Arlington, Va.
**MAGNETIC CHARACTERISTICS OF DEEP LAYERS OF OCEANIC CRUST AND STRUCTURE OF ANOMALOUS MAGNETIC FIELD IN OCEAN Abstract Only** **c48**
Ye. A. Nazarova and A. M. Gorodnitskiy *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 24 Transl. into ENGLISH from Okeanologiya (Moscow, USSR), v. 26, no. 3, May - Jun. 1986 p 446-450 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

A study was made of the magnetic characteristics of rock samples from deep layers of the ocean crust obtained by deep drilling on several cruises of the Glomar Challenger and dredging in the equatorial Atlantic. An analysis of these rocks revealed that serpentinized peridotites are characterized by quite strong and stable magnetization comparable to the magnetization of basalts of the second layer. Like basalts, they have the necessary magnetic characteristics for being sources of magnetic anomalies. On the other hand, fresh cumulative gabbros and amphibolitized and serpentinized gabbros of layers 2B and 3A cannot be sources of magnetic anomalies. Peridotites in layer 3B, with serpentinization, as a result of formation of secondary magnetite, acquires a chemical magnetization which is strong and stable in direction. The nature of distribution of I sub n for drilled and dredged serpentinites is similar, clearly suggesting that they have a common genesis. Unfortunately, there is no adequate serpentinite model of the magnetically active layer in the ocean crust. Much additional experimental and theoretical work is required for clarification of the serpentinization of peridotites. Author

**N87-27290#** Joint Publications Research Service, Arlington, Va.
**SEDIMENTARY STRUCTURE OF CENTRAL BASIN IN PACIFIC OCEAN Abstract Only** **c48**
G. A. Semenov, O. V. Levchenko, V. N. Moskalenko, and P. N. Kuzmin *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 24-25 Transl. into ENGLISH from Okeanologiya (Moscow, USSR), v. 26, no. 3, May - Jun. 1986 p 451-459 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

Continuous seismic profiling was carried out in the Central Basin of the Pacific Ocean during the 28th cruise of the scientific research ship Dmitriy Mendeleyev. The studied areas were work ranges 5 and 7 directly to the northeast of the Magellan Rise. The sounding profiles were used in constructing maps of the thickness of the sedimentary layer and relief of the acoustic basement. Drilling data were used in the interpretation of the results. The findings for each of the work ranges are given in detail. Despite a general similarity of the structure of the sedimentary layer in both work ranges, there are distinct differences. The first is located within the limits of an abyssal plain with a depth of about 6 km, characterized by gentle bottom relief. The thickness of the sedimentary layer remains approximately constant at 175 to 200 m. The simple two-layer section of the sedimentary layer is evidently typical for the abyssal basins in the western part of the Pacific Ocean. The second work range is characterized by a greater bottom and basement dissection. The more complex section of the sedimentary layer and considerable variations of its thickness, from 25 to 350 m, may be caused by erosional and accumulative processes operative here. Such findings can be used in studying the origin and distribution of ferromanganese nodules which occur extensively in the studied region. Author

**N87-27291#** Joint Publications Research Service, Arlington, Va.
**DEEP SEISMIC SOUNDING OF SUBCRUSTAL LITHOSPHERE IN SOUTH ATLANTIC Abstract Only** **c48**
S. M. Zverev, G. A. Yaroshevskaya, Yu. V. Tulina, G. A. Krasilshchikova, N. M. Nardov, V. M. Shablitskiy, O. A. Beresnev, V. K. Illarionov, and N. A. Pavlenkova *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 32-33 Transl. into ENGLISH from Doklady Akademii Nauk SSSR (Moscow, USSR), v. 289, no. 2, Jul. 1986 p 322-327 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

Studies of the South Atlantic lithosphere were made along deep seismic sounding profiles in 1980 to 1984 along the Angola-Brazil geotraverse. Self-contained bottom seismic stations were placed at 77 points along a line with a total length of 5,000 km. About 400 powerful shots were set off and pneumatic sound sources were activated thousands of times. Data are now processed for the eastern half of the geotraverse. Systems of counter and overtaking travel-time curves were obtained in all sectors and sections were constructed for all these sectors. There were two sectors with anomalous behavior of the seismic wave

field. The most clearly expressed anomaly was in a zone of abyssal hills between 1 and 3 deg W. The boundaries of the anomalous zone reveal wave indications of large faults extending for great depths into the mantle. The second anomalous zone is the axial part of the Mid-Atlantic Ridge. In the mantle in this zone there is evidently some special body having either a decreased velocity of propagation of seismic waves or increased absorption. In the studied sector of the South Atlantic crustal structure is everywhere close to typically ocean. The Moho is at depths of 11 to 12 km, slightly uplifted toward the axis of the ridge. The first boundary has its highest position beneath the basin and in the zone of abyssal hills. A possible petrologic and tectonic interpretation of the data is given and possible explanations for the anomalous sectors are considered. Author

**N87-27292#** Joint Publications Research Service, Arlington, Va.
**STRESSES IN UPPER MANTLE OF ACTIVE MARGINS OF OCEAN Abstract Only** **c46**
S. A. Boldyrev, A. B. Yefimov, and N. M. Naumova *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 34-35 Transl. into ENGLISH from Vulkanologiya i Seysmologiya (Moscow, USSR), no. 3, May - Jun. 1986 p 90-96 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

An attempt was made to evaluate the possible stresses arising in the mantle due to lateral density variations without invoking a priori concepts concerning the rheology of the mantle matter. Computations are given for a case when density variations are determined from data on velocity inhomogeneities of the transition zone from the ocean to the continent of the Pacific Ocean type. The probable source of elastic deformations, expressed as earthquakes, is inhomogeneity of the physicochemical properties of the mantle and accordingly, lateral density variations. It was assumed that density and velocity variations are linearly related. The basis for the computations was the three-dimensional field of the velocity of P waves in the region taking in the Kurile-Kamchatka island arc and adjacent sectors of the Sea of Okhotsk and Pacific Ocean to depths of 650 km. The greatest velocity changes were at a depth of 150 to 250 km. The sharpest changes of mantle properties in the transition zone are across the strike of the island arc. The stress-strained state was computed numerically using stipulated density inhomogeneities in a rectangular grid with a 50 km interval. The proposed method made it possible to evaluate the most general properties of dynamics of deep matter on the active margins of the ocean: the order of magnitude of effective viscosity and rate of movement, nature of distribution of stresses and the generalized picture of movement of mantle matter.
Author

**N87-27293#** Joint Publications Research Service, Arlington, Va.
**CALCULATION OF EARTH-MOON SYSTEM TIDAL EVOLUTION BASED ON MATHEMATICAL MODEL OF TIDES IN PALEO-OCEAN Abstract Only** **c48**
Ye. V. Polyakov *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 37 Transl. into ENGLISH from Izvestiya an SSSR: Fizika Atmosfery i Okeana (Moscow, USSR), v. 22, no. 5, May 1986 p 505-512 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

Changes over the course of millennia are regarded to have contributed to the evolution of the Earth-Moon tidal pattern. An attempt to calculate this evolution during the Phanerozoic using estimates of the dissipation of tidal energy based on mathematical calculations is presented. A combination integral and differential equations are presented and discussed. A series of applied calculations involving nine variants of water and dry land, including the present distribution, and eight suggested paleoreconstructions were examined. The mathematical calculations suggested an eneven development during the Phanerozoic, involving continental movement and changes in tidal forces. The increasing distance between the Earth and the Moon was regarded as a major factor in tidal changes, along with variations in the ocean's shape and resonant qualities. Author

**N87-27294#** Joint Publications Research Service, Arlington, Va.
**SIMULATION OF MODERN CLIMATE BASED ON OCEAN-ATMOSPHERE-ICE SYSTEM Abstract Only** **c47**
M. Ya. Verbitskiy and D. V. Chalikov *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 37-38 Transl. into ENGLISH from Izvestiya an SSSR: Fizika Atmosfery i Okeana (Moscow, USSR), v. 22, no. 5, May 1986 p 458-467 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

Study of long-range climate patterns is enhanced by models of the ocean-atmosphere-continental ice system. Improvements in the components of such a system model by mathematical revisions of earlier variants are reported. Ocean water temperatures were divided into zones of seasonal change or constant temperature. A divergent form of heat transfer in a vertical plane was projected for all four zones of the ocean model. The Antarctic Ocean, where interaction between the other oceans takes place, was regarded to have a temperature pattern expressed by an integral heat balance. Other calculations are presented for variations in the continental ice cover, the overall system model, and interactions between the extent and thickness of ice cover and atmospheric conditions, such as wind circulation. The model indicates that the latitude to which the ocean continues to emit heat is higher than previously suggested. Empirical data are contradictory and can only give general confirmation of the mathematical model proposed. Author

**N87-27295#** Joint Publications Research Service, Arlington, Va.
**FREQUENCY SPECTRA OF OCEAN SURFACE TEMPERATURE ANOMALIES Abstract Only** **c48**
L. I. Piterbarg *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 38 Transl. into ENGLISH from Izvestiya an SSSR: Fizika Atmosfery i Okeana (Moscow, USSR), v. 22, no. 3, Mar. 1986 p 301-309 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

Anomalies in ocean surface temperatures (AOST) were studied in the recent years because of their impact on climatic and synoptic processes. Statistical methods and mathematical models, taking into account the air-water contact boundary, the average thickness of the upper quasihomogeneous layer (UQL), and thermal factors are presented. Theoretical data and 16 years of observational data collected at 59 deg N, 19 deg W were found to agree closely. Further research, aimed at developing temperature projections for various surface point, was also conducted. The results showed the manner in which various factors of spatial AOST relationships affect the spectra observed. Theoretical findings were compared with 15 years of data collected from the North Atlantic in the 35 to 40 deg N, 15 to 70 deg W region. A second mathematical model took account of random periodic fluctuations in the seasonal component of vector rates, showing how these fluctuations distort the spectra and seeking to determine if they lead to peaks on the spectral curve. Author

**N87-27296#** Joint Publications Research Service, Arlington, Va.
**VOLCANIC-TECTONIC MODEL OF OCEAN FORMATION Abstract Only** **c48**
A. Ye. Svyatlovskiy *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 50 Transl. into ENGLISH from Vulkanologiya i Seysmologiya (Moscow, USSR), no. 3, May - Jun. 1986 p 3-11 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

Based on a report presented at the International Geological Congress in Moscow in 1984, this article suggests a somewhat new theory on the means by which the oceans came into existence. It is postulated that major inhomogeneities in the structure of the oceanic crust attest to its structural formation under the influence of vertical and horizontal tectonic movements in association with volcanism and sedimentation. An attempt can be made to reconcile or integrate the theoretical premises of structural analysis of the ocean floor (continental drift and the expansion of the Earth). It is proposed that telescoped riftogenesis, volcanic-tectonic processes in volcanic zones, in application to the oceans, solves the fundamental problems involved in interpreting their structure without

need for recourse to other hypotheses. On such a basis it then becomes possible to explain the symmetric increase in the age of basalts in the second layer of the ocean floor in the direction of the continents, the sequential change in the vertical section of bottom deposits upward from the second layer basalts to shallow water limestones and abyssal clays and the decrease in the extent of Mesozoic and Cenozoic continental transgressions and regressions as a result of an increase in the volume of oceanic basins with a narrowing of volcanic-tectonic zones of uplifts and rifting toward the centers of the oceans, accompanied by a corresponding decrease in the area of basalt outpourings.

Author

**N87-27297#** Joint Publications Research Service, Arlington, Va.
**ATMOSPHERIC FRONT PRECIPITATION INTENSITY SPECTRA Abstract Only** **c47**
A. A. Lyakhov and N. P. Shakina *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 53 Transl. into ENGLISH from Izvestiya Akademii Nauk SSSR: Fizika Atmosfery i Okeana (Moscow, USSR), v. 22, no. 7, Jul. 1986 p 712-719 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

Precipitation intensity spectra were computed for zones of atmospheric fronts during the warm season of the year. The study was based on measurements of temporal and spatial changes in precipitation intensity as registered in a special pluviographic test range of the State Hydrological Institute at Valday. The analyzed data were obtained during the passage of two warm and three cold fronts. The precipitation field usually consisted of one or two main zones of increased rainfall intensity. One is associated directly with the frontal line, whereas the other is parallel to it and displaced relative to the front in the direction of the cold air. The width of this second zone, the intensity of convective processes and precipitation in it can be greater than for the first. In the course of frontal evolution there are transitions from one to two zone structure and back. With high resolution of data it is possible to detect smaller-scale structural details, such as secondary, weaker bands superposed on the system of main zones. The literature contains virtually no information on precipitation intensity spectra for middle-latitude cyclones, although such information is highly important for understanding the structure of the precipitation field and vertical movements. Author

**N87-27298#** Joint Publications Research Service, Arlington, Va.
**ATMOSPHERIC WIND SOUNDING USING CONTINUOUS DOPPLER SYSTEMS Abstract Only** **c46**
A. G. Gorelik and V. V. Sterlyadkin *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 54 Transl. into ENGLISH from Izvestiya Akademii Nauk SSSR: Fizika Atmosfery i Okeana (Moscow, USSR), v. 22, no. 7, Jul. 1986 p 720-727 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

The principal shortcoming of presently available methods for determining the vertical wind profile in the lower layers of the atmosphere is the difficulty of their use under extreme conditions, such as during the falling of heavy precipitation, when strong winds are blowing, during hurricanes, or in thick fogs. The possibility of determining the vertical wind profile from the form of the spectrum of a reflected signal when using Doppler stations with continuous unmodulated radiation was pointed out. Such a continuous Doppler system is unrestricted with respect to the range of measured wind velocities and therefore the development of all-weather wind sounding measurements on their basis is entirely feasible. A changeover to the submillimeter and optical wavelength ranges is very desirable. Aerosols and other wind-entrained inhomogeneities can serve as scatters. The joint operation of continuous Doppler systems in the optical and microwave ranges would make it possible to carry out wind measurements regardless of weather. Formulas are derived for solving the inverse problem of retrieving the wind profile in the boundary layer from spectra obtained with continuous Doppler systems. The advantages of operating in the optical range are discussed. Author

**N87-27299#** Joint Publications Research Service, Arlington, Va.
**LIGHT PROPAGATION IN STRATIFIED MEDIUM WITH HIGHLY ANISOTROPIC SCATTERING Abstract Only** **c46**
V. S. Remizovich, D. B. Rogozkin, and M. I. Ryazanov *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 55 Transl. into ENGLISH from Izvestiya Akademii Nauk SSSR: Fizika Atmosfery i Okeana (Moscow, USSR), v. 22, no. 7, Jul. 1986 p 736-742 Original language document was announced in IAA as A87-15236 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

An analysis is made of the transmission of light through a turbid medium with strongly anisotropic scattering: the absorption and scattering characteristics of the medium fluctuate along the light propagation direction. The exact analytical solution of the transfer equation is obtained for an exponential model of the turbid medium. It is shown that, when at large depths absorption predominates over scattering, the anisotropy of the angular distribution of the transmitted radiation is most pronounced. IAA

**N87-27300#** Joint Publications Research Service, Arlington, Va.
**VARIABILITY OF TEMPERATURE FLUCTUATION SPECTRA IN ATMOSPHERIC BOUNDARY LAYER Abstract Only** **c47**
V. A. Bezverkhniy, A. S. Gurvich, and V. P. Kukharets *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 55-56 Transl. into ENGLISH from Izvestiya Akademii Nauk SSSR: Fizika Atmosfery i Okeana (Moscow, USSR), v. 22, no. 7, Jul. 1986 p 675-681 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

A study was made of the variability of spectra of turbulent temperature fluctuations theta in the atmospheric boundary layer. The spectra were computed using a relatively large number of relatively short segments of a quite long theta(t) record obtained on magnetic tape during aircraft flight. Flights were at an altitude of 750 or 250 m along a straight line at a speed of 64 m/s. The theta measurements were made with a resistance thermometer. Intermittence was investigated using the spectral-time analysis method modified applicable to the study of random processes with the power-law spectra. The statistics of the periodograms obtained along the short flight path segments was analyzed, making it possible to obtain the first quantitative estimates of the intermittence of turbulence in the boundary layer. In the inertial interval of frequencies each of the periodograms can be approximated by a power law Af sup b, where f is frequency, A and b are random parameters. The distribtion of probabilities of periodogram values differs greatly from the Chi squared law with the degree of the difference being governed by the ratio of the internal scale to the length of the segment. Author

**N87-27301#** Joint Publications Research Service, Arlington, Va.
**IMPROVED METHOD FOR DETERMINING VERTICAL REFRACTION Abstract Only** **c46**
V. V. Vinogradov *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 56-57 Transl. into ENGLISH from Geodeziya i Kartografiya (Moscow, USSR), no. 7, Jul. 1986 p 18-20 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

A method is proposed for determining vertical refraction on the basis of measurements of fluctuations of the angles of incidence of a light wave by a highly precise theodolite. The method is compared with a similar method described by V. Ye. Dementyev, and a method based on determining the angular diameter of image blurring of a radial mire. The distinguishing feature of the proposed method is that it is possible to determine the angle of vertical refraction directly from the zenith distances measured with a theodolite, that is, from the integral parameters of the refraction trajectory, which correctly reflects the state of the atmospheric surface layer. There is no need for organizing special bases with known relative elevations between the ends of the trajectory in order to compute the angles of refraction. There is no need for organizing special bases with known relative elevations between the ends of the trajectory in order to compute the angles of refraction. The method has an accuracy comparable to the methods proposed earlier. The method was tested in the field in 1983

along a path measuring about 1,150 m and careful checking revealed that the method under many conditions is both more convenient, but also comparable in accuracy to methods employed earlier. Author

**N87-27302#** Joint Publications Research Service, Arlington, Va.
**SPECTRAL LIGHT SCATTERING COEFFICIENTS FOR ATMOSPHERIC SURFACE LAYER Abstract Only** **c46**
M. A. Derbisalin, G. Sh. Livshits, and O. D. Tokarev *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 57 Transl. into ENGLISH from Izvestiya Akademii Nauk SSSR: Fizika Atmosfery i Okeana (Moscow, USSR), v. 22, no. 6, Jun. 1986 p 588-594 Original language document was announced in IAA as A87-10379 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

Results of measurements of scattering coefficients carried out over an extensive time period in the 0.4 to 0.9 micron spectral range are presented; these relate to both continental aerosol and industrial haze. The drift in the nephelometric scattering angle is studied as a function of observational conditions and optical wavelength. Several characteristic types of spectral dependences of the aerosol scattering coefficient are discerned; these correspond to distinct types of atmospheric haze. The relationship between scattering coefficients and meteorological parameters and the dry fraction of the aerosol is discussed. IAA

**N87-27303#** Joint Publications Research Service, Arlington, Va.
**USE OF SPHERICAL HARMONICS IN DETERMINING RADIATION TRANSFER IN BROKEN CLOUDS Abstract Only** **c47**
T. B. Zhuravleva and G. A. Titov *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 58 Transl. into ENGLISH from Izvestiya Akademii Nauk SSSR: Fizika Atmosfery i Okeana (Moscow, USSR), v. 22, no. 6, Jun. 1986 p 600-606 Original language document was announced in IAA as A87-10381 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

For average shortwave optical radiation intensity in broken clouds, a system of equations is solved using spherical harmonics. Solutions as well as numerical estimates of the accuracy of the mean radiative flux calculations are presented in the p1-approximation. It is noted that calculations carried out with the p1-approximation are much less time-consuming than those carried out with the Monte Carlo method. IAA

**N87-27304#** Joint Publications Research Service, Arlington, Va.
**GIANT AEROSOL CLOUDS STUDIED WITH AIRBORNE LASER COMPLEX Abstract Only** **c47**
L. Levitskiy *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 58-59 Transl. into ENGLISH from Izvestiya (Moscow, USSR) 8 Aug. 1986 p 3 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

Airborne equipment is being used to study mesoscale aerosol clouds. Mesoscale aerosol clouds are said to be invisible to the human eye. The particles are so small that they produce practically no effect on scattering of light. The particles are found with the aid of superprecise instruments which detect differences between the passage of a laser beam through a cluster of aerosol particles and through clear air. The clouds which are largely of natural origin, form in clear weather at altitudes of 1,200 to 3,500 meters through the action of anticyclones, growing to lengths as great as 40 kilometers and become as thick as 1 kilometer. It is believed that aerosol clusters become nuclei around which ordinary clouds form through condensation of water vapor. Observations of such clusters' movements thus may lead to more accurate weather forecasting. Two flights made from Novosibirsk to Chardzhou, aboard an IL-14 laboratory aircraft, are described. Observations of aerosol clouds were observed with the aid of a laser complex, which included a photoelectric counter and electronic equipment for receiving and interpreting target signals. B.G.

**N87-27305#** Joint Publications Research Service, Arlington, Va.
**POSSIBILITY OF DETERMINING EFFECTIVE PROTON PAIR LENGTH IN CLOUDS IN IR SPECTRAL REGION USING CO2 ABSORPTION BAND 2.06 MICRON Abstract Only** **c46**
Ye. I. Grechko, S. V. Dvoryashin, and V. I. Dianov-Klokov *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 59-60 Transl. into ENGLISH from Izvestiya Akademii Nauk SSSR: Fizika Atmosfery i Okeana (Moscow, USSR), v. 22, no. 6, Jun. 1986 p 607-615 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

In studying the energetics of the cloudy atmosphere valuable information can be obtained by investigating the extinction of solar and terrestrial radiation in the absorption bands of atmospheric gases. Data on the path lengths of photons forming fluxes reflected and transmitted by clouds can be used, especially the effective path length l sub eff, the path length of photons in a nonscattering absorbing atmosphere, along which the extinction of radiation is equivalent to the attenuation of radiation due to absorption in a scattering and absorbing atmosphere. Such a study was made using the absorption band of carbon dioxide. The optical density of this band was studied at the absorption maxima of the R- and P-branches as a function of variations of the temperature profiles and moisture content in an atmospheric column. The atmosphere was broken down into 16 layers with constant pressure, temperature, CO2 and water vapor contents in making the needed computations in conjunction with summer and winter model temperature profiles. The influence of absorption of the droplet water of clouds on l sub eff was studied and it was found that l sub eff measured in the CO2 absorption band is close to the path determined by absorption by cloud droplet water. Author

**N87-27306#** Joint Publications Research Service, Arlington, Va.
**VARIATIONS IN OPTICAL PROPERTIES OF STRATOSPHERIC AEROSOL Abstract Only** **c46**
M. S. Kiseleva *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 60 Transl. into ENGLISH from Izvestiya an SSSR: Fizika Atmosfery i Okeana (Moscow, USSR), v. 22, no. 5, May 1986 p 497-504 Original language document was announced in IAA as A86-49953 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

Solar radiation attenuation spectra obtained using an airborne spectrometer in the 0.4 to 2.2 micron range over the European position of the USSR and in Central Asia are examined. It is observed that the optical characteristics of the stratosphere can vary within this broad spectral range. The effective size and concentration of small and medium-size particles for transparent and turbid stratospheric conditions are calculated. For both statospheric states, very high concentrations of small particles (0.02 to 0.06 micron) of Aitken nuclei type are detected. The effects of medium-size particles (0.2 to 0.3 microns) on transparent and turbid states are analyzed. The data reveal that the influence of the particles on visible radiation attenuation in the transparent stratosphere is small; however, in the turbid state the role of the particles is dominant. IAA

# 43 EARTH RESOURCES AND REMOTE SENSING

Includes remote sensing of earth resources by aircraft and spacecraft; photogrammetry; and aerial photography.

For instrumentation see *35 Instrumentation and Photography.*

**N87-27307*#** State Univ. of New York, Albany. Atmospheric Sciences Research Center.
**MEASUREMENT OF HEAT AND MOISTURE FLUXES AT THE TOP OF THE RAIN FOREST DURING ABLE Final Report**
David R. Fitzjarrald 10 Jul. 1987 64 p
(Grant NAG1-583)
(NASA-CR-181076; NAS 1.26:181076) Avail: NTIS HC A04/MF A01 CSCL 02F

Observations are presented of turbulent heat, moisture, and momentum transport made at two levels, approximately 5 and 10 m above the Amazon rain forest canopy. Data acquired at 10 Hz included variances and some mixed third moments of vertical velocity, temperature, and humidity. Two features of the data appear to question the displacement height hypothesis: (1) The characteristic dissipation length scale in the near-canopy layer varied between 20 m in stable conditions to approximately 150 m during afternoon convective conditions, generally larger scales than would be expected; and (2) No appreciable difference in dissipation scales was seen at the two observed levels. Observed peaks in vertical velocity-temperature cospectra lead to similar length scale estimates for dominant eddies. Heat budgets on selected days show that frequent periods with negative heat flux concurrent with continuing positive moisture flux occur in early afternoon, and this is believed to indicate the patchy nature of canopy-atmosphere coupling. Vertical velocity skewness was observed to be negative on three successive days and exhibited a sharp positive gradient.
Author

**N87-27308#** Central Intelligence Agency, Washington, D.C. Office of Geographic and Cartographic Research.
**CAM (CARTOGRAPHIC AUTOMATIC MAPPING) PROGRAM DOCUMENTATION, 7TH EDITION**
Mar. 1987 36 p Previously announced as N78-11498
(PB87-171872; CIA/SW/MT-87/001A) Avail: NTIS HC A03/MF A01 CSCL 08B

The Cartographic Automatic Mapping (CAM) Program is the output portion of AUTOMAP, an automatic mapping system developed by the CIA. CAM performs a variety of cartographic functions. The structure of the program is modular so that additional map projections, subroutines to read line or symbol data invarious formats, subroutines for other features, and different plotter software can be added. The User Guide will assist the user in the implementation of the program.
GRA

**N87-27309#** Army Engineer Topographic Labs., Fort Belvoir, Va.
**NON-LINEAR CONTOUR-TO-GRID DIGITAL INTERPOLATION**
Betty A. Mandel, Christoph Wizgall, and Javier Bernal 10 Oct. 1986 11 p
(AD-A180632; ETL-R091) Avail: NTIS HC A02/MF A01 CSCL 08B

A technical approach to the task of performing a contour to grid conversion using nonlinear interpolation has been studied. The approach consists of reconstructing a terrain surface from the digitized contour lines on a map. The approximating surface is defined in terms of a partition of the region into irregular triangles obtained by a Voronoi method. The vertices of the triangles are selected by sampling a large set of digitized contour data with a tolerance band technique. The result is a smooth synthetic surface with which the elevation of any given point can be calculated. Therefore, grids of any given dimensions can be generated.
GRA

**N87-27310#** Naval Air Development Center, Warminster, Pa.
**THE FEASIBILITY OF DETECTING A MAGNETIC FIELD FROM A DISTANT PLATFORM Final Report**
Martin Squicciarini 15 May 1987 15 p
(AD-A180635) Avail: NTIS HC A02/MF A01 CSCL 17F

The long term objective of the Remote Magnetic Sensing (REMAS) project is to study the feasibility of detecting a magnetic field from a distant platform. This can be contrasted with the current method of magnetic sensing that employs an ASQ-81 helium magnetometer housed in a P-3 aircraft. The ASQ-81 must be located within close proximity of the target in order to detect a field but the presence of the P-3 introduces the possibility of distorting the field and thereby invalidating the measurement. However, this dilemma can be circumvented if a remote sensing device is employed to accomplish the field measurements. The platform is removed from the target area and therefore cannot influence the field. An added advantage of remote sensing is its ability to generate a two dimensional field map of the ocean's surface. These features make the study of systems capable of remotely sensing a magnetic field both a provocative and potentially profitable endeavor.
GRA

**N87-27311#** Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
**SPACE SURVEILLANCE APPLICATION POTENTIAL OF SCHOTTKY BARRIER IR SENSORS**
Michael J. Cantella 9 Apr. 1987 42 p
(Contract F19628-85-C-0002)
(AD-A180848; TR-772; ESD-TR-86-142) Avail: NTIS HC A03/MF A01 CSCL 17E

Schottky Barrier IR detection is based on the principle of internal photoemission at the surface between a Si substrate and a deposited metal. In a multi-element focal plane array (FPA), this phenomenon provides very high pixel-to-pixel uniformity, so the requirement for corrective signal processing is minimal. The use of standard silicon design and fabrication techniques simplifies detector readout and multiplexing functions and permits practical realization of sensors that contain very large staring focal planes. This report summarizes the status of FPA and camera development and includes typical imagery. For surveillance applications, the high sensitivity obtainable with these large staring arrays offers both signature and background phenomenoiogy opportunities in the medium wavelength (MWIR) band which could not be exploited previously with scanning-type sensors. Examples of predicted surveillance sensor performance include (1) a near-term ground-based system for Day/Night detection of low-altitude space objects and (2) a future space-borne system for space missions.
GRA

**N87-27312#** Colorado Univ., Boulder. Inst. of Arctic and Alpine Research.
**VEGETATION AND A LANDSAT-DERIVED LAND COVER MAP OF THE BEECHEY POINT QUADRANGLE, ARCTIC COASTAL PLAIN, ALASKA**
Donald A. Walker and William Acevedo Apr. 1987 72 p
(Contract DACA89-81-K-0006)
(AD-A180931; CRREL-87-5) Avail: NTIS HC A04/MF A01 CSCL 08B

This report presents a LANDSAT-derived land cover classification of the Beechey Point, Alaska, 1:250,000-scale quadrangle with descriptions of the major vegetation units. Eight LANDSAT-level units derived from multispectral scanner data, eleven photo-interpreted units, and eight common vegetation complexes are described. The region is divided into four landscape units: flat thaw-lake plains, gently rolling thaw-lake plains, hill, and flood plains. Area analysis of the quadrangle was done according to townships and nine small study areas. The map uses a modified version of the hierarchical tundra mapping classification of Walker (1983). Area-measurement data from geobotanical maps at eight study sites are compared with similar data from LANDSAT maps of the same sites. The results indicate that LANDSAT maps yield area measurements corresponding to broad geobotanical categories.
GRA

**N87-27313#** Naval Ocean Research and Development Activity, Bay St. Louis, Miss.
**COLLECTING REQUIREMENTS FOR AN INTERNATIONAL GEOGRAPHIC NAMES PROCESSING SYSTEM Final Report**
Gail Langran Oct. 1986 48 p
(AD-A181276; NORDA-147) Avail: NTIS HC A03/MF A01 CSCL 08B

The Defense Mapping Agency (DMA) is responsible for collecting and maintaining a correct file of geographic placenames worldwide to support a variety of U.S government activities. All placenames must be documented with an array of data that includes feature type, position, and possibly some feature attributes; all names previously or currently associated with the feature; reference sources used to acquire the names data ; and information concerning the Board on Geographic Names' Foreign Names Committee ruling on the features's names. Currently, all such data is recorded on approximately 4.5 million paper index cards via

pen, pencil, or typewriter. DMA plans to augment the card file with a digital geographic names data base. Working with placenames data in a digital environment, however, means that hardware and software must be available to enter, view, edit, and print the diacritics and special symbols used in foreign text. Lack of such hardware and software has been a major stumbling block in establishing an operational digital data base for DMA's toponymic use. This report describes the needs, uses, interfaces, and data characteristics of digital geographic names processing system (GNPS) for DMA. The GNPS will manage a names data base and provide software for foreign text processing. GRA

**N87-27314#** Office of Naval Research, London (England).
**THE INTERNATIONAL SYMPOSIUM ON MICROWAVE SIGNATURES AND REMOTE SENSING HELD IN GOTHENBURG (SWEDEN) ON 19-22 JANUARY 1987**
Jerome Williams 28 May 1987 13 p Symposium held in Gothenburg, Sweden, 19-22 Jan. 1987
(AD-A181334; ONRL-7-010-C) Avail: NTIS HC A02/MF A01 CSCL 17I

Discussions covered signatures from snow and ice, solid ground, ocean surfaces, and vegetation and considered systems and radar altimetry, interactions and modeling, and new methods. GRA

**N87-27315*** National Aeronautics and Space Administration, Washington, D.C.
**EARTH RESOURCES: A CONTINUING BIBLIOGRAPHY WITH INDEXES (ISSUE 54)**
Aug. 1987 164 p
(NASA-SP-7041(54); NAS 1.21:7041(54)) Avail: NTIS HC A08 CSCL 05B

This bibliography lists 562 reports, articles, and other documents introduced into the NASA scientific and technical information system between April 1 and June 30, 1987. Emphasis is placed on the use of remote sensing and geophysical instrumentation in spacecraft and aircraft to survey and inventory natural resources and urban areas. Subject matter is grouped according to agriculture and forestry, environmental changes and cultural resources, geodesy and cartography, geology and mineral resources, hydrology and water management, data processing and distribution systems, instrumentation and sensors, and economic analysis. Author

**N87-27316*#** National Aeronautics and Space Administration, Washington, D.C.
**HMMR (HIGH-RESOLUTION MULTIFREQUENCY MICROWAVE RADIOMETER) EARTH OBSERVING SYSTEM, VOLUME 2e. INSTRUMENT PANEL REPORT**
1987 70 p Original contains color illustrations
(NASA-TM-89625; NAS 1.15:89625) Avail: NTIS HC A04/MF A01 CSCL 14B

Recommendations and background are provided for a passive microwave remote sensing system of the future designed to meet the observational needs of Earth scientist in the next decade. This system, called the High Resolution Multifrequency Microwave Radiometer (HMMR), is to be part of a complement of instruments in polar orbit. Working together, these instruments will form an Earth Observing System (EOS) to provide the information needed to better understand the fundamental, global scale processes which govern the Earth's environment. Measurements are identified in detail which passive observations in the microwave portion of the spectrum could contribute to an Earth Observing System in polar orbit. Requirements are established, e.g., spatial and temporal resolution, for these measurements so that, when combined with the other instruments in the Earth Observing System, they would yield a data set suitable for understanding the fundamental processes governing the Earth's environment. Existing and/or planned sensor systems are assessed in the light of these requirements, and additional sensor hardware needed to meet these observational requirements are defined. Author

**N87-27317** Ohio State Univ., Columbus.
**DETERMINATION OF EARTH ROTATION BY THE COMBINATION OF DATA FROM DIFFERENT SPACE GEODETIC SYSTEMS Ph.D. Thesis**
Brent Allen Archinal 1987 189 p
Avail: Univ. Microfilms Order No. DA8709972

Fifteen days of observations were simulated using the realistic networks of Lunar Laser Ranging (LLR), Satellite Laser Ranging (SLR) to Lageos, and Very Long Baseline Interferometry (VLBI) stations to test the premise that a simultaneous solution using data from several sources would provide an improved determination of Earth Rotation Parameters (ERP), i.e., polar motion and universal time. These simulations show that solutions done by the normal equation combination and grand solution methods provide the best or nearly best ERP for all of the periods considered, but that weighted mean solutions provide nearly the same accuracy and precision. VLBI solutions also provide ERP of similar accuracies. Author

**N87-27318*#** National Aeronautics and Space Administration, Washington, D.C.
**EXPEDITION TO LAKE ELGYTKHYN**
I. A. Nekrasov Jul. 1987 20 p Transl. into ENGLISH from Expeditsiya na Ozero Elgytkhyn, Problemy Severa (USSR), Iss. 1, AN SSSR, p 360-370 Transl. by The Corporate Word, Inc., Pittsburgh, Pa.
(Contract NASw-4006)
(NASA-TT-20051; NAS 1.77:20051) Avail: NTIS HC A02/MF A01 CSCL 08H

A description of a spring-summer expedition to Lake El'Gytkhin in 1955 and preliminary conclusions based on incomplete processing of materials based on the expedition's findings are presented. Author

**N87-27319#** Helsinki Univ. of Technology, Espoo (Finland). Dept. of Electrical Engineering.
**ANALYSIS OF MICROWAVE STRUCTURES AND MIXING FORMULAE WITH APPLICATIONS TO REMOTE SENSING MEASUREMENTS Ph.D. Thesis**
Ari Sihvola Nov. 1986 23 p
(Rept-8; ISBN-951-753-973-8; ISSN-0782-0607; ETN-87-90055)
Avail: NTIS HC A02/MF A01

Mixing theories corroborated by experimental results were derived to connect the volume fractions of constituents composing a mixture and its electrically measurable effective permittivity, permitting the indirect measurement of nonelectrical properties. By measuring the complex effective permittivity of the material, the real part and the losses, two nonelectrical parameters can be determined. One example is the fractional composition of a three-component mixture, like the wetness and density of wet snow. More information about the structure of mixtures exhibiting dispersion can be gathered by repeating the electrical measurement at different frequencies. Multifrequency measurement is indispensable for more than three-phase mixtures and for applications where the microstructure of the material is of interest because a plain volume-fraction description of the mixture is not exhaustive. ESA

**N87-27320#** World Meteorological Organization, Geneva (Switzerland).
**INTERCOMPARISON OF MODELS OF SNOWMELT RUNOFF**
1986 468 p
(WMO-646; OH-23; ISBN-92-63-10646-0; ETN-87-90060)
Copyright Avail: NTIS MF A01; print copy available at WMO, Geneva, Switzerland SWFR 51

Operational models of snowmelt runoff were tested using data sets for six river catchments from climatologically and geographically varied conditions. Each data set consisted of a calibration period (6 yr) and a verification period (4 yr) following immediately after. For each data set, the model owners were supplied with concurrent observed input data (precipitation, evaporation, and other meteorological data) and observed output data (streamflow) for the calibration period and only observed

input data for the verification period. For each data set the model owners used the concurrent observed input and output data for the calibration period to calibrate and develop the parameters of their models, and employed the observed input data in the verification period to produce a simulated discharge (computed output). The simulated discharges produced for the calibration and verification periods in each data set were compared using graphical and numerical verification criteria. ESA

**N87-27321#** Joint Publications Research Service, Arlington, Va.
**USSR REPORT. MATERIALS SCIENCE AND METALLURGY. COMPLEX SUBSATELLITE OCEANOGRAPHIC EXPERIMENT OF THE USSR AND GDR ON THE BALTIC SEA**
11 May 1987 102 p Transl. into ENGLISH of Kompleksnyy Podspytnikovyy Okeanograficheskiy Eksperiment SSSR i GDR na Baltiyskom More (Leningrad, USSR, Gidrometeoizdat), 1985 p 1-105 Original language document was announced in IAA as A86-35473
(JPRS-UMS-87-005) Copyright Avail: NTIS HC A06/MF A01

An experiment comparing synchronized space-, air-, and ship-based data on various oceanographic and meteorological characteristics of a region in the Baltic Sea is described. The topics discussed include the role of correlated space-air-surface studies in developing sensing methods, basic information concerning the complex space-air-surface oceanographic experiment, the collection of the satellite and the supporting oceanographic data in a model regional data bank, hydrooptic studies in the central region of the Baltic Sea, and complex studies of the Baltic Sea temperature field. Particular attention is given to the structure of the data bank, the evaluation of the sea color index from transatmospheric measurements, and an analysis of the satellite data on the temperature field of the Baltic Sea surface using estimated atmospheric corrections. Author

**N87-27282#** Joint Publications Research Service, Arlington, Va.
**SYSTEMS OF COUPLED GYROSTATS IN PROBLEMS IN GEOPHYSICAL HYDRODYNAMICS Abstract Only**
A. B. Glukhovskiy *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 1 Transl. into ENGLISH from Izvestiya Akademii Nauk SSSR: Fizika Atmosfery i Okeana (Moscow, USSR), v. 22, no. 7, Jul. 1986 p 701-711 Original language document was announced in IAA as A87-15232 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

# 44 ENERGY PRODUCTION AND CONVERSION

Includes specific energy conversion systems, e.g., fuel cells; global sources of energy; geophysical conversion; and windpower.

For related information see also *07 Aircraft Propulsion and Power, 20 Spacecraft Propulsion and Power,* and *28 Propellants and Fuels.*

**N87-27322*#** Old Dominion Univ., Norfolk, Va. Dept. of Mathematical Sciences.
**A THEORETICAL STUDY OF PHOTOVOLTAIC CONVERTERS Progress Report, 16 May 1986 - 1 Jan. 1987**
John H. Heinbockel Jan. 1987 11 p
(Grant NAG1-148)
(NASA-CR-180635; NAS 1.26:180635) Avail: NTIS HC A02/MF A01 CSCL 10A

Mathematical models for the photovoltaic conversion of laser power were developed. These models simulate the operation of planar and vertical junction photovoltaic converters and are described in detail. B.G.

**N87-27323*#** Old Dominion Univ., Norfolk, Va. Dept. of Mathematical Sciences.
**A THEORETICAL STUDY OF PHOTOVOLTAIC CONVERTERS Final Report, period ending 16 May 1987**
John H. Heinbockel May 1987 20 p
(Grant NAG1-148)
(NASA-CR-180956; NAS 1.26:180956) Avail: NTIS HC A02/MF A01 CSCL 10A

The final phase of research was performed in the model simulation for the solar simulator pumped atomic iodine laser. The geometry for the steady state laser operation with axial lasant flow is illustrated. The chemical kinetics for this laser are described. Author

**N87-27324*#** International Fuel Cells Corp., South Windsor, Conn.
**REGENERATIVE FUEL CELL STUDY FOR SATELLITES IN GEO ORBIT Final Contractor Report**
Alexander Levy, Leslie L. VanDine, and James K. Stedman Jul. 1987 82 p
(Contract NAS3-22234)
(NASA-CR-179609; NAS 1.26:179609; FCR-8347) Avail: NTIS HC A05/MF A01 CSCL 10B

Summarized are the results of a 12-month study to identify high performance regenerative hydrogen-oxygen fuel cell concepts for geosynchronous satellite application. Emphasis was placed on concepts with the potential for high energy density (W-hr/lb) and passive means for water and heat management to maximize system reliability. Both polymer membrane and alkaline electrolyte fuel cells were considered, with emphasis on the alkaline cell because of its high performance, advanced state of development, and proven ability to operate in a launch and space environment. Three alkaline system concepts were studied. The first, the integrated design, utilized a configuration in which the fuel cell and electrolysis cells are alternately stacked inside a pressure vessel. Product water is transferred by diffusion during electrolysis and waste heat is conducted through the pressure wall, thus using completely passive means for transfer and control. The second alkaline system, the dedicated design, uses a separate fuel cell and electrolysis stack so that each unit can be optimized in size and weight based on its orbital operating period. The third design was a dual function stack configuration, in which each cell can operate in both fuel cell and electrolysis mode, thus eliminating the need for two separate stacks and associated equipment. Results indicate that using near term technology energy densities between 46 and 52 W-hr/lb can be achieved at efficiencies of 55 percent. System densities of 115 W-hr/lb are contemplated. Author

**N87-27325#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**FLAT-PLATE SOLAR ARRAY PROJECT. VOLUME 3: SILICON SHEET: WAFERS AND RIBBONS**
A. Briglio, K. Dumas, M. Leipold, and A. Morrison Oct. 1986 132 p
(Contract DE-AI01-85CE-89008)
(DE87-009243; DOE/JPL-1012-125-Vol-3) Avail: NTIS HC A07/MF A01

The primary objective of the Silicon Sheet Task of the FSA Project was the development of one or more low-cost technologies for producing silicon sheet suitable for processing into cost-competitive solar cells. Silicon sheet refers to high-purity crystalline silicon of size and thickness for fabrication into solar cells. The Task effort began with state-of-the-art sheet technologies and then solicited and supported any new silicon sheet alternatives that had the potential to achieve the Project goals. A total of 48 contracts was awarded that covered work in the areas of ingot growth and casting, wafering, ribbon growth, other sheet technologies, and programs of supportive research. Periodic reviews of each sheet technology were held, assessing the technical progress and the long-range potential. Technologies that failed to achieve their promise were dropped. A series of workshops was initiated to assess the state of the art, to provide insights into problems remaining to be addressed, and to support technology transfer. The Task made and fostered significant improvements in silicon sheet including processing of both ingot and ribbon technologies. An additional important outcome was the vastly improved understanding of other characteristics associated with

high-quality sheet, and the control of the parameters required for higher efficiency solar cells. Although significant sheet cost reductions were made, the technology advancements required to meet the Task cost goals were not achieved. DOE

**N87-27326#** Sandia National Labs., Albuquerque, N. Mex.
**PHOTOVOLTAIC ELECTRICAL SYSTEM DESIGN PRACTICE: ISSUES AND RECOMMENDATIONS**
Thomas Key and David Menicucci May 1987 23 p Presented at the 19th IEEE Photovoltaic Specialists Conference, New Orleans, La., 4 May 1987
(Contract DE-AC04-76DP-00789)
(DE87-009294; SAND-87-1159C; CONF-870528-13) Avail: NTIS HC A02/MF A01

As demand for photovoltaic (PV) power grows, so will the need to improve electrical subsystem safety and reliability. This paper documents some of the most significant electrical design problems and solutions experienced in fielded PV systems. The major focus is analysis of wiring, grounding and protection problems and employment of design lessons learned from their solution. Based on design experiences, general criteria are identified and electrical subsystem design practices are recommended for three classes of PV system applications. DOE

**N87-27327*#** Wichita State Univ., Kans.
**PERFORMANCE AND AERODYNAMIC BRAKING OF A HORIZONTAL-AXIS WIND TURBINE FROM SMALL-SCALE WIND TUNNEL TESTS Final Report**
H. V. Cao and W. H. Wentz, Jr. Jul. 1987 43 p
(Grant NsG-3277)
(NASA-CR-180812; DOE/NASA/3277-4; NAS 1.26:180812)
Avail: NTIS HC A03/MF A01 CSCL 10A

Wind tunnel tests of three 20' diameter, zero twist, zero pitch wind turbine rotor models were conducted in a 7' x 10' wind tunnel to determine the performance of such rotors with NACA 23024 and NACA 64 sub 3-621 airfoil sections. Aerodynamic braking characteristics of a 38% span, 30% chord, vented aileron configuration were measured on the NACA 23024 rotor. Surface flow patterns were observed using fluorescent mini-tufts attached to the suction side of the rotor blades. Experimental results with and without ailerons are compared to predictions using airfoil section data and a momentum performance code. Results of the performance studies show that the 64 sub 3-621 rotor produces higher peak power than the 23024 rotor for a given rotor speed. Analytical studies, however, indicate that the 23024 should produce higher power. Transition strip experiments show that the 23024 rotor is much more sensitive to roughness than the 64 sub 3-621 rotor. These trends agree with analytical predictions. Results of the aileron test show that this aileron, when deflected, produces a braking torque at all tip speed ratios. In free wheeling coastdowns the rotor blade stopped, then rotated backward at a tip speed ratio of -0.6. Author

**N87-27328#** Spire Corp., Bedford, Mass.
**RESEARCH ON HIGH-EFFICIENCY, STACKED, MULTI-JUNCTION, AMORPHOUS SILICON ALLOY THIN-FILM SOLAR CELL Semiannual Subcontract Report, 15 Oct. 1985 - 30 Apr. 1986**
V. Dalal Jan. 1987 64 p Prepared in cooperation with Midwest Research Inst., Golden, Colo.
(Contract DE-AC02-83CH-10093)
(DE87-001142; SERI/STR-211-3104) Avail: NTIS HC A04/MF A01

This report describes work performed to investigate and develop high-efficiency, multijunction amorphous silicon alloy thin-film solar cells. Specifically, a-Si:H and a-(Si,Ge):H alloys have been deposited and characterized chemically, structurally, optically, and electronically. Also, a-Si:H/a-(Si,Ge):H high-efficiency tandem solar cells have been fabricated and analyzed. In this contract period, a plasma-isolated, two-chamber, hot-wall glow discharge reactor began operating. Good quality a-Si:H layers were grown. A chemical vapor deposition (CVD) pyrolytic reactor for depositing SnO:F layers on glass was also used. Single-junction a-Si:H cells up to 9.1% in efficiency were fabricated, as were multijunction a-Si:H/a-(Si,Ge):H cells up to 7.2% in efficiency. DOE

**N87-27329#** Harvard Univ., Cambridge, Mass. Div. of Applied Sciences.
**AMORPHOUS HYDROGENERATED SILICON GERMANIUM ALLOYS SUITABLE FOR PHOTOELECTRONIC APPLICATIONS Annual Subcontract Report, 1 Jul. 1985 - 30 Jun. 1986**
W. Paul and K. D. Mackenzie Jan. 1987 58 p Prepared in cooperation with Midwest Research Inst., Golden, Colo.
(Contract DE-AC02-83CH-10093)
(DE87-001143; SERI/STR-211-3107) Avail: NTIS HC A04/MF A01

This report covers the second year of a two-year project to produce amorphous silicon-germanium alloys from mixtures of hydrides and from mixtures of fluorides and to compare the photoelectronic properties of the two preparations. In the first year we successfully prepared these alloys by both methods, with a range of compositions adequate to provide the low-band-gap material desired in tandem solar cells. We also measured infrared vibrational absorption, optical absorption edge spectra, photoconductivity spectra, photoluminescence spectra, and conductivity versus temperature. In the second year we made more extensive measurements, on a wider variety of samples, of all of those properties. We also obtained measurements by the time-of-flight technique to obtain electron mu tau products, and we measured the sub-band-gap absorption by the constant photocurrent method. The report also includes collaborative measurements of the dangling bond densities from electron spin resonance and preliminary measurements of the gap-state densities estimated from measurements of the space-charge-limited current. DOE

**N87-27330#** Midwest Research Inst., Golden, Colo.
**POLYCRYSTALLINE THIN FILMS Annual Report, FY 1986**
K. Zweibel, R. Mitchell, and H. Ullal Feb. 1987 49 p
(Contract DE-AC02-83CH-10093)
(DE87-001152; SERI/PR-211-3073) Avail: NTIS HC A03/MF A01

This annual report for fiscal year 1986 summarizes the status, accomplishments, and projected future research directions of the Polycrystalline Thin Film Task in the Photovoltaic Program Branch of the Solar Energy Research Institute's Solar Electric Research Division. Subcontracted work in this area has concentrated on the development of CuInSe2 and CdTe technologies. During FY 1986, major progress was achieved by subcontractors in (1) achieving 10.5% (SERI-verified) efficiency with CdTe, (2) improving the efficiency of selenized CuInSe2 solar cells to nearly 8%, and (3) developing a transparent contact to CdTe cells for potential use in the top cells of tandem structures. DOE

**N87-27331#** Spire Corp., Bedford, Mass.
**DEVELOPMENT OF METALLIZATION FOR GaAs AND AlGaAs CONCENTRATOR SOLAR CELLS**
S. P. Tobin Apr. 1987 113 p
(Contract DE-AC04-76DP-00789)
(DE87-007951; SAND-86-7052) Avail: NTIS HC A06/MF A01

A three-layer metallization system was developed for high temperature stability on GaAs and AlGaAs solar cells. The layers are a Pt ohmic contact metal that forms thermally stable compounds with GaAs, a TiN diffusion barrier, and a gold conductor. The solar cell structure was also designed for contact stability, with the key component being a heavily doped GaAs cap layer. Reactively sputtered TiN was found to act as an excellent barrier when deposited under the proper conditions. The conditions were carefully optimized for low resistivity and low stress in the films. A low but nonzero substrate bias during sputtering was found to be important. Solar cells with sputtered metallizations of Pt/TiN/Ti/Pt/Au were found to be thermally stable up to 500°C for 15 minutes in vacuum. At 600°C there was catastrophic degradation of the cells due to dissociation of uncapped GaAs surfaces. Below this temperature the metallization performed as designed. The Pt and GaAs layers reacted to form a stable PtGa

compound layer that gave low contact resistance. There was no penetration of Au or GaAs through the barrier layer. These results are a very encouraging first step leading to stable, reliable GaAs and AlGaAs concentrator cells. DOE

**N87-27332#** Sandia National Labs., Albuquerque, N. Mex.
**MAGMA ENERGY**
J. C. Dunn 1987 5 p Presented at the 5th Geothermal Program Review, Washington, D.C., 14 Apr. 1987
(Contract DE-AC04-76DP-00789)
(DE87-009834; SAND-87-1253C; CONF-8704110-7) Avail: NTIS HC A02

The thermal energy contained in magmatic systems represents a huge potential resource. In the US, useful energy contained in molten and partially-molten magma within the upper 10 km of the crust has been estimated at 5 to 50 x 10 to the 22 power J (50,000 to 500,000 Quads). The objective of the Magma Energy Extraction Program is to determine the engineering feasibility of locating, accessing, and utilizing magma as a viable energy resource. This program follows the DOE/OBES-funded Magma Energy Research Project that concluded scientific feasibility of the magma energy concept. A primary long-range goal of this program is to conduct an energy extraction experiment directly in a molten, crustal magma body. Critical to determining engineering feasibility are several key technology tasks: (1) Geophysics - to obtain detailed definition of potential magma targets, (2) Geochemistry/Materials - to characterize the magma environment and select compatible engineering materials, (3) Drilling - to develop drilling and completion techniques for entry into a magma body, and (4) Energy Extraction - to develop heat extraction technology. DOE

**N87-27333#** New South Wales Univ., Kensington (Australia). Joint Microelectronics Research Centre.
**HIGH-EFFICIENCY SILICON CONCENTRATOR SOLAR CELLS**
M. A. Green, A. W. Blakers, Zhao Jianhua, M. Taouk, S. Narayanan, and P. Campbell May 1987 128 p
(Contract DE-AC04-76DP-00789)
(DE87-010158; SAND-87-7007) Avail: NTIS HC A07/MF A01

Recent developments in the non-concentrating silicon cell area have been applied to concentrator cells. This has resulted in a marked improvement in low-resistivity concentrator cell energy conversion efficiency to values in the 23 to 25% range at 50 to 150 suns concentration with values above 20% recorded out to 1,000 suns. Processing requirements for high-resistivity silicon cells have also been explored with one-sun open-circuit voltages in the 630 to 640-mV range demonstrated on both p-type and n-type high-resistivity substrates. The latter n-type substrates are argued to have the better long-term potential from the point of view of fabricating high-efficiency, bifacially contacted cells on such high-resistivity substrates. Light trapping based on both randomizing and geometrical schemes is examined. It is concluded that light trapping is particularly relevant to concentrator cells and may allow 30% module efficiency to be reached using thin silicon cells. DOE

# 45 ENVIRONMENT POLLUTION

Includes atmospheric, noise, thermal, and water pollution.

**N87-27285#** Joint Publications Research Service, Arlington, Va.
**REACTION OF OCEAN-ATMOSPHERE SYSTEM TO DOUBLING OF ATMOSPHERIC CO2 CONTENT AND ITS SEASONAL VARIABILITY Abstract Only**
B. A. Kagan, V. A. Ryabchenko, and A. S. Safray *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 19 Transl. into ENGLISH from Okeanologiya (Moscow, USSR), v. 26, no. 3, May - Jun. 1986 p 365-375 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

# 46 GEOPHYSICS

Includes aeronomy; upper and lower atmosphere studies; ionospheric and magnetospheric physics; and geomagnetism.

For space radiation see *93 Space Radiation.*

**N87-27334*#** Old Dominion Univ., Norfolk, Va. Dept. of Geological Sciences.
**DEVELOPMENT OF DATA PROCESSING, INTERPRETATION AND ANALYSIS SYSTEM FOR THE REMOTE SENSING OF TRACE ATMOSPHERIC GAS SPECIES Final Report, 22 Jan. 1982 - 15 Jan. 1986**
Joseph C. Casas, Mary S. Saylor, and Earl C. Kindle Apr. 1987 39 p
(Contract NCC1-34)
(NASA-CR-180619; NAS 1.26:180619; GSTR-87-1) Avail: NTIS HC A03/MF A01 CSCL 04A

The major emphasis is on the advancement of remote sensing technology. In particular, the gas filter correlation radiometer (GFCR) technique was applied to the measurement of trace gas species, such as carbon monoxide (CO), from airborne and Earth orbiting platforms. Through a series of low altitude aircraft flights, high altitude aircraft flights, and orbiting space platform flights, data were collected and analyzed, culminating in the first global map of carbon monoxide concentration in the middle troposphere and stratosphere. The four major areas of this remote sensing program, known as the Measurement of Air Pollution from Satellites (MAPS) experiment, are: (1) data acquisition, (2) data processing, analysis, and interpretation algorithms, (3) data display techniques, and (4) information processing. Author

**N87-27335*#** Virginia Univ., Charlottesville. Dept. of Environmental Sciences.
**ATMOSPHERIC SURFACE AND BOUNDARY LAYERS OF THE AMAZON BASIN Final Report**
Michael Garstang 14 Mar. 1987 161 p
(Contract NCC1-95)
(NASA-CR-180628; NAS 1.26:180628) Avail: NTIS HC A08/MF A01 CSCL 04A

Three phases of work were performed: design of and preparation for the Amazon Boundary Layer Experiment (ABLE 2-A); execution of the ABLE 2-A field program; and analysis of the ABLE 2-A data. Three areas of experiment design were dealt with: surface based meteorological measurements; aircraft missions; and project meteorological support. The primary goal was to obtain a good description of the structure of the atmosphere immediately above the rain forest canopy (top of canopy to a few thousand meters), to describe this region during the growing daytime phase of the boundary layer; and to examine the nighttime stratified state. A secondary objective was to examine the role that deep convective storms play in the vertical transport of heat, water vapor, and other trace gases. While significant progress was made, much of the analysis remains to be done. B.G.

**N87-27336#** International Centre for Theoretical Physics, Trieste (Italy).
**ESTIMATION OF MONTHLY AVERAGE HOURLY GLOBAL AND DIFFUSE IRRADIATION**
P. C. Jain Dec. 1985 39 p
(DE87-701756; IC-85/262) Avail: NTIS (US Sales Only) HC A03/MF A01

Hourly solar irradiation data of Montreal are analyzed. Eleven-year monthly average values of the ratio hourly/daily of the global as well as the diffuse irradiation on a horizontal plane are plotted against the solar time for each of the 12 months. The normal distribution curve suggested for analyzing the hourly global irradiation data of Trieste is found to fit both the data fairly well. The mean of the normal curve is taken at the solar noon. The sigma values are obtained by matching the experimental and the theoretical values at the solar noon. These sigma values are found to be related to bar-S(0) by the equation sigma = 0.209 bar-sigma(0) + 0.294 for the global irradiation and by the equation

sigma = 0.222 bar-sigma(0) + 0.270 for the diffuse radiation, with excellent coefficients of correlation. DOE

**N87-27337** ESDU International Ltd., London (England).
**CHARACTERISTICS OF ATMOSPHERIC TURBULENCE NEAR THE GROUND. PART 2: SINGLE POINT DATA FOR STRONG WINDS (NEUTRAL ATMOSPHERE)**
Oct. 1985 24 p Supersedes ESDU-74031
(ESDU-85020-Pt-2; ESDU-74031; ISBN-0-85679-526-7; ISSN-0143-2702) Avail: ESDU

ESDU 85020 is one of a series giving comprehensive turbulence characteristics for neutral atmosphere conditions which includes strong winds. It provides turbulence intensity, Reynolds stresses, probability and spectral density, and integral length scale for longitudinal, lateral, and vertical components of wind speed at a single point. The data apply to heights of at least 1000 ft (300 m) and to a range of terrain equivalent roughnesses, including upwind terrain with roughness changes. The theoretical background to the derivation is given, using similarity theory applied to the atmospheric boundary layer and models based on measurements from the most reliable sources. It allows extrapolation of results obtained at moderate wind speeds to much higher wind speeds when, in particular, longer length scales are found. Modified spectral equations are derived that account for anisotropic turbulence near the ground. ESDU

**N87-27338*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**METHANE FLUX FROM THE CENTRAL AMAZONIAN FLOODPLAIN Final Report**
Karen B. Bartlett, Patrick M. Crill, Daniel I. Sebacher, Robert C. Harriss, John O. Wilson, and John M. Melack (California Univ., Santa Barbara.) 13 Aug. 1987 51 p
(Grant NAG1-563)
(NASA-TM-89296; NAS 1.15:89296) Avail: NTIS HC A04/MF A01 CSCL 04A

A total of 186 methane measurements from the three primary Amazon floodplain environments of open water lakes, flood forests, and floating grass mats were made over the period 18 July through 2 September 1985. These data indicate that emissions were lowest over open water lakes. Flux from flooded forests and grass mats was significantly higher. At least three transport processes contribute to tropospheric emissions: ebullition from sediments, diffusion along the concentration gradient from sediment to overlaying water to air, and transport through the roots and stems of aquatic plants. Measurements indicate that the first two of these processes are most significant. It was estimated that on the average bubbling makes up 49% of the flux from open water, 54% of that from flooded forests, and 64% of that from floating mats. If the measurements were applied to the entire Amazonian floodplain, it is calculated that the region could supply up to 12% of the estimated global natural sources of methane. Author

**N87-27339*#** Texas A&M Univ., College Station. Dept. of Meteorology.
**AN INITIAL APPROACH TO THE UTILIZATION OF VAS SATELLITE SOUNDING DATA**
Kyung-Sup Shin and James R. Scoggins Dec. 1984 54 p
(Contract NAS8-34735)
(NASA-CR-179002; NAS 1.26:179002) Avail: NTIS HC A04/MF A01 CSCL 04A

The primary objective is the development of methods to utilize satellite soundings. To achieve that, a more precise understanding of the characteristics of satellite derived soundings is required. The initial approach in the utilization of satellite soundings is to find a way to combine rawinsondes and satellite data into a unified data set. If this can be done in a meaningful way, satellite data could be integrated into existing data and interpretation would be enhanced. In this attempt, both rawinsonde and satellite soundings will be decomposed by the use of the Fourier cosine series. Then, each harmonic will be compared to get a better understanding of the representativeness of the satellite sounding data. Harmonics taken from satellite and rawinsonde soundings will be combined to provide a unified data set that can be used both over data sparse ocean areas as well as over land where rawinsonde data are available. B.G.

**N87-27340*#** Texas A&M Univ., College Station. Dept. of Geophysics.
**ALTIMETRY DATA AND THE ELASTIC STRESS TENSOR OF SUBDUCTION ZONES Final Report, 1 Sep. 1980 - 28 Feb. 1987**
Michele Caputo 19 Aug. 1987 46 p
(Grant NAG5-94)
(NASA-CR-181182; NAS 1.26:181182; RF-4340) Avail: NTIS HC A03/MF A01 CSCL 08G

The maximum shear stress (mss) field due to mass anomalies is estimated in the Apennines, the Kermadec-Tonga Trench, and the Rio Grande Rift areas and the results for each area are compared to observed seismicity. A maximum mss of 420 bar was calculated in the Kermadec-Tonga Trench region at a depth of 28 km. Two additional zones with more than 300 bar mss were also observed in the Kermadec-Tonga Trench study. Comparison of the calculated mss field with the observed seismicity in the Kermadec-Tonga showed two zones of well correlated activity. The Rio Grande Rift results showed a maximum mss of 700 bar occurring east of the rift and at a depth of 6 km. Recorded seismicity in the region was primarily constrained to a depth of approximately 5 km, correlating well to the results of the stress calculations. Two areas of high mss are found in the Apennine region: 120 bar at a depth of 55 km, and 149 bar at the surface. Seismic events observed in the Apennine area compare favorably with the mss field calculated, exhibiting two zones of activity. The case of loading by seamounts and icecaps are also simulated. Results for this study show that the mss reaches a maximum of about 1/3 that of the applied surface stress for both cases, and is located at a depth related to the diameter of the surface mass anomaly. Author

**N87-27341*#** Rice Univ., Houston, Tex. Dept. of Electrical and Computer Engineering.
**AN ARTIFICIAL INTELLIGENCE TECHNIQUE FOR AUTOMATING SEISMIC STRATIGRAPHIC INTERPRETATION**
Scott W. Shaw and Rui J. DeFigueiredo 25 Nov. 1986 27 p
(Grant NGT-44-006-806)
(NASA-CR-181213; NAS 1.26:181213; AD-A181094) Avail: NTIS HC A03/MF A01 CSCL 08K

Studying the character of reflected seismic wavelets may reveal facts about the stratigraphy of the reflector. Computers can aid humans in this task by revealing structural similarities between various wavelets. The relational tree is a good way to represent a waveform's global structure. By representing a waveform as a relational tree, processing it symbolically, and clustering the processed trees, a seismic wave form recognition system can be constructed. The symbolic processing is based on a tree transformation. An objective function, which measures the effectiveness of such a transformation, utilizes the ratio of between-cluster to within-cluster scatter. The action of a tree transformation applied to tree spaces is the same as linear discriminants applied to feature spaces. When tested on simulated seismic data, the relational tree waveform recognition system performs well at high signal-to-noise ratios. GRA

**N87-27342#** Teledyne Geotechnical, Alexandria, Va.
**MODELS OF THE FREQUENCY DEPENDENCE OF Q IN THE MANTLE UNDERLYING TECTONIC AREAS OF NORTH AMERICA, EURASIA AND EASTERN PACIFIC Final Technical Report, Mar. 1985 - Sep. 1986**
Z. A. Der, W. W. Chan, A. C. Lees, and M. E. Marshall 30 Oct. 1986 167 p
(Contract F08606-85-C-0023; ARPA Order 4511)
(AD-A181178; TGAL-86-5) Avail: NTIS HC A08/MF A01 CSCL 08K

The results of wide-band data analyses for the determination of frequency dependent Q models of the mantle under the tectonic areas of Eurasia, North America and the Eastern Pacific are

presented. For tectonic areas of Eurasia, the spectra of short period P waves from Kazakh explosions are used to estimate t* in the 1 to 8 Hz range. Amplitude ratios of long period multiple ScS phases were used to estimate attenuation in the 0.3 to 0.9 Hz band. Under tectonic Eurasia, these analyses gave t* sub ScS of approx. 3.9 + or - 0.4 sec. Thus, for Eurasia, t*(f) for tectonic paths is approximately parallel to, but approximately 0.25 sec (for t* sub p) greater than t*(f) under the shield. For North America, the amplitudes of long period multiple ScS phases were analyzed for two type of paths. Multiple ScS amplitudes were recorded in the Northeastern US for events in the Aleutians (paths across the Canadian shield) and similar data were recorded in the Southeastern US for a Central American event. These data analyses show that the attenuation in the long period band in North America varied in the same sense regionally as shown in previous work in the short period band. For Eastern Pacific the upper mantle attenuation appears to be the highest of all regions studies with t* uniformly higher than in the two tectonic continental areas discussed above. These findings support the general idea that t*(f) curves for teleseismic paths crossing the upper mantle in various areas of the world generally do not converge towards the long period end of the seismic spectrum as implied by the absorption band shift models. GRA

**N87-27343#** Australian National Univ., Canberra. Research School of Earth Sciences.
**LONG NONLINEAR WAVES IN THE LOWER ATMOSPHERE Final Scientific Report, for period ending 31 Dec. 1985**
Douglas R. Christie 6 May 1987 82 p
(Grant AF-AFOSR-0045-83)
(AD-A181414; Rept-87-1; AFOSR-87-0780TR) Avail: NTIS HC A05/MF A01 CSCL 04B

A general theoretical treatment of long nonlinear wave propagation in the lower atmosphere is presented. The eigenvalue problem for finite-amplitude wave in a surface-based inversion is discussed in detail and expressions are obtained in closed form for the nonlinear wave parameters, surface perturbation pressure and wind components for a number of realistic boundary-layer waveguide models. The governing evolution equations for wave amplitude have been solved numerically for a wide variety of initial conditions and the results are found to compare favorably with observations. Nonlinear wave propagation in an inhomogeneous waveguide is also studied in detail. It is shown that both temporal and spatial variations in the degree of turbulent dissipation can induce significant changes in the speed of propagation and in the morphology of boundary-layer nonlinear wave disturbances. GRA

**N87-27344#** University Coll., London (England). Dept. of Physics and Astronomy.
**ATMOSPHERIC STRUCTURE VARIATIONS: MODELLING OF ATMOSPHERIC STRUCTURE, 70 - 130 KM Final Report, 1 Jan. 1984 - 31 Dec. 1986**
Gerald V. Groves 27 Apr. 1987 82 p
(Grant AF-AFOSR-0045-84)
(AD-A181459; AFOSR-87-0709TR) Avail: NTIS HC A05/MF A01 CSCL 04A

Theory and numerical analysis of data were applied to a number of leading problems of atmospheric structure in the upper mesosphere/lower thermosphere during the three years of this project. Three investigations occupied the first 18 months and concerned: (1) diurnal and semidiurnal tidal dissipation of momentum and energy in the upper atmosphere, (2) the modelling of O distribution from 85 km to the turbopause and (3) an empirical model for solar cycle changes in mesospheric structure. During the second part of the project, attention was concentrated on: (4) atmospheric modelling of the intermediate region (70 to 130 km) between given models for the lower (up to 70 km) region and the upper (above 130 km) region. A preliminary report of this work, to the extent that it might meet the needs of a new COSPAR reference atmosphere, was presented at the 1986 COSPAR meeting and a detailed report of the theory and analyses was subsequently completed. GRA

**N87-27345#** Naval Postgraduate School, Monterey, Calif.
**ESTIMATION OF EXTINCTION COEFFICIENTS AT 3.75 AND 11.00 MICROMETERS FROM SATELLITE MEASUREMENTS AT 0.63 AND 0.86 MICROMETER M.S. Thesis**
Margarita GarciaDeQuevedo Mar. 1987 56 p
(AD-A181461) Avail: NTIS HC A04/MF A01 CSCL 20F

A method for estimating extinction coefficients in the near-infrared and infrared wavelengths from satellite measurements in the visible was developed. Five tests were devised to examine the limits and sensitivity of the model. The first test studied the error inherent in the retrieval of the parameters which are needed to describe the distribution of atmospheric particles and are direct inputs for the calculation of extinction at 3.75 and 11.00 micro. Also studied were errors associated with uncertainties in the extinction values, uncertainties in relative humidity values, deviations of particle size distribution from the model and effects of high winds on the aerosol distribution. Results indicate that the biggest error results when wind generated aerosols change the particle size distribution especially at radii larger than 2 micro. GRA

**N87-27346#** National Oceanic and Atmospheric Administration, Boulder, Colo.
**THE EFFECTS OF DOPPLER SHIFTING ON THE FREQUENCY SPECTRA OF ATMOSPHERIC GRAVITY WAVES Final Report**
Thomas E. VanZandt and David C. Fritts Jan. 1987 56 p
(Grants AF-AFOSR-ISSA-86-0050; AF-AFOSR-ISSA-87-0080)
(AD-A181747; AFOSR-87-0624TR) Avail: NTIS HC A04/MF A01 CSCL 04A

Spectra of atmospheric motions as a function of observed frequency may depart significantly from the spectra as a function of intrinsic frequency due to a nonzero mean wind. This paper examines the effects of Doppler shifting on a model spectrum of atmospheric gravity waves. To gain insight into the effects of Doppler shifting, we derived analytic solutions by approximation of the intrinsic frequency spectra and the gravity wave dispersion relation. Our results reveal that Doppler shifting can have major effects on the observed frequency spectrum of both horizontal and vertical gravity wave energy. For levels of Doppler shifting representative of the lower and middle atmosphere, possible effects include a substantial enhancement of horizontal energy density at higher observed frequencies, a corresponding reduction of the vertical energy density at higher frequencies, and a significant transfer of vertical energy to observed frequencies above the buoyancy frequency. The predicted effects are found to be consistent with some of the features of the observed frequency spectra. Anisotropy; Dissipation. GRA

**N87-27347** Case Western Reserve Univ., Cleveland, Ohio.
**SIGNAL MODELS AND PROCESSING FOR QUASI-OPTICAL ATMOSPHERIC PROPAGATION STUDIES WITH AN APPLICATION TO NEAR-MILLIMETER WAVES Ph.D. Thesis**
Jeffrey J. Sitterle 1987 147 p
Avail: Univ. Microfilms Order No. DA8710099

The modeling, simulation and analysis of millimeter and near-millimeter wave signals obtained with a reflective antenna are discussed. Using a model based on smooth fluctuation theory, the power spectrums of the intensity scintillation and angle-of-arrival fluctuation are derived for a general beamwave shape and finite transmitter and receiver apertures. The results are then incorporated into a simulation model which is used to predict the receiver output under a wide variety of atmospheric conditions or experimental setups. From simulated signals, three different signal processing methods are derived for the estimation of the angle-of-arrival statistics, the probability density function of the intensity scintillation, and the mutual coherence function from the spatially sampled focal plane irradiance pattern. Dissert. Abstr.

**N87-27348** Cornell Univ., Ithaca, N.Y.
**CHIRPED INCOHERENT SCATTER RADAR PLASMA LINE MEASUREMENTS Ph.D. Thesis**
Wolfram Siegfried Birkmayer 1987 198 p
Avail: Univ. Microfilms Order No. DA8708863

The detectability of the plasma line in incoherent scatter radar experiments on the ionospheric plasma can be increased by factors in the range of 10 to 50 by chirping the transmitter frequency and the receiver local oscillator at a rate matching the linear change of plasma line frequency with height. The method of observation is explained in detail and experiments carried out at the Arecibo Observatory are described. Dissert. Abstr.

**N87-27349** Wisconsin Univ., Madison.
**THE EFFECTS OF STRATIFICATION AND VERTICAL WIND SHEAR ON ATMOSPHERIC SOLITARY AND CNOIDAL GRAVITY WAVES: A NUMERICAL INVESTIGATION Ph.D. Thesis**
Eric Dale Skyllingstad 1986 181 p
Avail: Univ. Microfilms Order No. DA8702328

The generation and stability of atmospheric solitary and cnoidal gravity waves are examined with a non-hydrostatic, compressible numerical model. The possibility of unstable cnoidal and solitary wave systems in the atmosphere is shown by the model results. Dissert. Abstr.

**N87-27350#** National Oceanic and Atmospheric Administration, Washington, D. C. National Environmental Satellite, Data and Information Service.
**COMPLEMENTARY ROLES OF MICROWAVE AND INFRARED INSTRUMENTS IN ATMOSPHERIC SOUNDING**
L. McMillin, H. Fleming, D. Gray, N. Grody, and A. Reale Feb. 1987 34 p
(PB87-184917; NOAA-TR-NESDIS-29) Avail: NTIS HC A03/MF A01 CSCL 04A

Radiance measurements in the infrared and microwave regions respond differently to changes in the atmosphere. These differences in response lead to differences in the ability to derive profiles of atmospheric parameters such as temperature and moisture. A summary of the characteristics of each region is presented, followed by an evaluation of the results of simulation studies and extrapolations from existing instruments, both of which were designed to assess the relative advantages of the two wavelength regions. The studies show that the combination of the information from the two spectral regions leads to more accurate retrievals than can be obtained from either spectral region alone at all levels of the atmosphere. GRA

**N87-27351#** Alaska Univ., Fairbanks. Div. of Geological and Geophysical Surveys.
**SUMMARY OF ALASKA EARTHQUAKES FOR THE PERIOD JULY, AUGUST AND SEPTEMBER 1985**
H. Pulpan and J. N. Davies Mar. 1987 33 p
(PB87-183463; RI-87-3) Avail: NTIS HC A03/MF A01 CSCL 08K

Listed are the parameters of earthquakes occurring in or near areas encompassed by the network of seismograph stations operated or recorded by the University of Alaska Geophysical Institute (UAGI). The goal is to provide a convenient reference source for earthquake activity in the seismic-network area. The report contains hypocentral parameters and information about the quality of data and precision of the parameters. GRA

**N87-27352#** National Geophysical Data Center, Boulder, Colo.
**SOLID EARTH GEOPHYSICS: DATA SERVICES**
Jan. 1987 23 p
(PB87-184107; KGRD-22) Avail: NTIS HC A02/MF A01 CSCL 08G

The National Oceanic and Atmospheric Administration (NOAA) collects, manages, and disseminates many kinds of scientific data that result from the inquiry into the environment. The National Geophysical Data Center (NGDC), one of the several data-management centers of NOAA, is responsible for data activities in the fields of seismology, gravity, topography, geomagnetism, geothermics, marine geology and geophysics, and solar-terrestrial physics. The pamphlet briefly describes the principal products and services NGDC provides through its Solid Earth (SEG) division. Among the most important activities of SEG are acquiring and archiving data, processing and formatting data into standard sets, developing useful data products for customers, and advertising and disseminating data to the scientific, academic, and industrial communities. GRA

**N87-27353** Princeton Univ., N. J.
**NONLINEARITY IN TRANSIENT, TWO-DIMENSIONAL FLOW OVER TOPOGRAPHY Ph.D. Thesis**
Julio Tonatium Bacmeister 1987 311 p
Avail: Univ. Microfilms Order No. DA8709210

The roles of transience and nonhydrostatic motions in flow over topography are studied with a time dependent, nonhydrostatic numerical model. First, the stability of solutions of Long's model is examined. Solutions of Long's model are used to initialize nonlinear, numerical experiments. No instabilities occur for mountains to within 10 percent of critical height for overturning by Long's model. The evolution of weakly nonlinear flows started from rest is compared with that of linear flow over the same topography. It is found that nonlinear, transient motions can significantly lengthen the time required to reach steady state. They can cause the low level momentum flux to exceed the steady state value given by Long's model by 25 percent or more. The source of these secondary motions appears to be the momentum flux convergences produced during the vertical propagation of the mountain wave. Dissert. Abstr.

**N87-27354#** Stockholm Univ. (Sweden). Dept. of Meteorology.
**ON THE HYSTERETIC BEHAVIOR OF MOIST CONVECTION**
Xiang-Yu Huang Feb. 1987 46 p
(DM-49; ISSN-0349-0467; ETN-87-90077) Avail: NTIS HC A03/MF A01

Two-dimensional moist convection was studied with a Boussinesq approximated model, where the effect of moisture is only taken into account as a flow dependent heating. To confirm the existence of the hysteretic behavior of moist convection in the presence of many horizontal motion scales, a high resolution model was investigated, taking a large number of wave components. By numerically integrating the high resolution model with a slowly varying static stability hysteretic behavior is observed as a quasi-equilibrium feature of the model. Varying the dissipation time scale and the height of the lifting condensation level shows that hysteretic behavior is most significant with a weak dissipation and a low lifting condensation level. Transient characteristics of the model were investigated, where the diurnal cycle is simulated by a time varying static stability. The sudden transition from a state of rest to a state of convection disappears if the dissipation is too weak. ESA

**N87-27355#** Stockholm Univ. (Sweden). Inst. of Theoretical Physics.
**CHANDLER WOBBLES AND THE GEOMAGNETIC FIELD**
Stig Flodmark and K. Davstad Nov. 1986 69 p Presented at the 10th European Geophysical Society, Kiel, West Germany, Aug. 1986
(Contract NFG-G-GU-2059-111)
(USIP-86-13; ETN-87-90078) Avail: NTIS HC A04/MF A01

Paleomagnetic motion of the magnetic pole is explained by angular momentum balance between the magnetic field, inner core, outer core, and mantle. The Chandler wobbles are explained as a nutation of the mantle and crust, caused by transfer of angular momentum between the core and mantle. Evidence is found for the atmosphere not to be fully responsible for the annual oscillation period of the Chandler wobbles. The main reasons for the principal periods of 12 and 14 months are found to be the flattenings of mantle and core, respectively. The fluid core rotates collectively, as a consequence of globally coworking long-distance electromagnetic coupling. Short-distance forces may locally displace fluid core material without essentially deforming its ellipsoid of inertia. The longitudinal polar drifts of the mantle and outer core are also explained by core-mantle interaction. The core is found to force the Chandler period on the mantle, and it has high wobbling energy in comparison with the mantle. ESA

**N87-27356#** Uppsala Ionospheric Observatory (Sweden).
**THE 27-DAY PERIODIC RECURRENCE OF IONOSPHERIC STORMS**
Harald Derblom Jan. 1987 80 p
(Contract FOA-310775)
(UIO-SR-87-03; ISSN-0349-2699; ETN-87-90081) Avail: NTIS HC A05/MF A01

The 27-day recurrence tendency of geomagnetic and ionospheric disturbances is related to solar rotation and activity. Eighteen years of hourly ionospheric data from the Swedish stations Uppsala (temperate latitude zone), Lycksele (subauroral zone) and Kiruna (auroral zone) are analyzed in the light of possible recurring disturbances. Parameters foF2, M(3000) and B are emphasized. The recurrence seems to be clearest manifested in the B-notations (blackout) in the Kiruna data. By tracking the bunches of blackouts from one solar rotation to another is it found that a disturbance recurs with 70% probability for up to six 27-day periods. For a prediction 2 solar rotations in advance (54 days), the confidence level declines to 53%. The recurrence tendency can be filtered out of the ionosonde data with quite high confidence. It is suggested that, based on a simple filtering technique, prediction of possible disturbed periods be included in HF median frequency predictions. ESA

**N87-27357#** Kiruna Geophysical Inst. (Sweden).
**[ACTIVITIES REPORT IN GEOPHYSICS] Annual Report, 1986**
1987 57 p
(ISSN-0283-1986; ETN-87-90083) Avail: NTIS HC A04/MF A01

Geostationary particle distribution measurements with GEOS 1 and 2; boundary layer studies with PROGNOZ 7 and 8; and Viking (Swedish satellite) studies of auroral field lines, wave-particle interactions; the Giotto mission are areas of activity in research discussed. In addition, theoretical studies of the magnetosphere and magnetotail; and ground based projects using EISCAT, radio, and optical methods are summarized. Laboratory simulation of plasma is described. ESA

**N87-27358#** Kiruna Geophysical Inst. (Sweden).
**THE OPTICAL LABORATORY IN KIRUNA (SWEDEN): A NEW RESEARCH FACILITY IN THE AURORAL ZONE**
Aake Steen Feb. 1987 20 p
(KGI-TR-033; ISSN-0349-2672; ETN-87-90084) Avail: NTIS HC A02/MF A01

The layout and equipment of a laboratory for auroral research are described. ESA

**N87-26938#** Institut d'Aeronomie Spatiale de Belgique, Brussels.
**THE QUIET AND DISTRUBED PLASMASPHERE**
J. Lemaire *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 7 p Previously announced as N87-22498 (For primary document see N87-26937 21-18)
Copyright Avail: NTIS HC A13/MF A01 CSCL 22B

**N87-26939#** Utah State Univ., Logan. Center for Atmospheric and Space Sciences.
**MAGNETOSPHERIC CONTROL OF THE BULK IONOSPHERIC PLASMA**
J. J. Sojka and R. W. Schunk *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 14 p (For primary document see N87-26937 21-18)
(Grant NSF ATM-84-17880)
Copyright Avail: NTIS HC A13/MF A01

**N87-26940#** Institut d'Aeronomie Spatiale de Belgique, Brussels.
**A MODEL FOR AN ELECTROMOTIVE FORCE GENERATOR IN THE MAGNETOSPHERE: A SOURCE OF DISCRETE AURORAL ARCS**
M. Roth, D. S. Evans (National Oceanic and Atmospheric Administration, Boulder, Colo.), and J. Lemaire *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 12 p Previously announced as N87-17421 (For primary document see N87-26937 21-18)
Copyright Avail: NTIS HC A13/MF A01

**N87-26941#** Los Alamos National Lab., N. Mex.
**HOSTILE ENERGETIC PARTICLE RADIATION ENVIRONMENTS IN EARTH'S OUTER MAGNETOSPHERE**
D. N. Baker, R. D. Belian, P. R. Higbie, R. W. Klebesadel, and J. B. Blake (Aerospace Corp., El Segundo, Calif.) *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 16 p Previously announced as N86-32018 (For primary document see N87-26937 21-18)
Copyright Avail: NTIS HC A13/MF A01

**N87-26942#** Royal Aircraft Establishment, Farnborough (England). Radio and Navigation Dept.
**THE USE OF PI2 PULSATIONS AS INDICATORS OF SUBSTORM EFFECTS AT GEOSTATIONARY ORBIT**
M. Lester *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 9 p (For primary document see N87-26937 21-18)
Copyright Avail: NTIS HC A13/MF A01

**N87-26943#** Stanford Univ., Calif. STAR Lab.
**WAVE-INDUCED PARTICLE PRECIPITATION FROM THE MAGNETOSPHERE AND THE ASSOCIATED IONOSPHERIC PERTURBATIONS**
U. S. Inan *In* AGARD, The Aerospace Environment at High Altitudes and its Implications for Spacecraft Charging and Communications May 1987 10 p (For primary document see N87-26937 21-18)
(Grants NSF DPP-82-17820; NSF DPP-80-22282)
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**N87-27292#** Joint Publications Research Service, Arlington, Va.
**STRESSES IN UPPER MANTLE OF ACTIVE MARGINS OF OCEAN Abstract Only**
S. A. Boldyrev, A. B. Yefimov, and N. M. Naumova *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 34-35 Transl. into ENGLISH from Vulkanologiya i Seysmologiya (Moscow, USSR), no. 3, May - Jun. 1986 p 90-96 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

**N87-27298#** Joint Publications Research Service, Arlington, Va.
**ATMOSPHERIC WIND SOUNDING USING CONTINUOUS DOPPLER SYSTEMS Abstract Only**
A. G. Gorelik and V. V. Sterlyadkin *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 54 Transl. into ENGLISH from Izvestiya Akademii Nauk SSSR: Fizika Atmosfery i Okeana (Moscow, USSR), v. 22, no. 7, Jul. 1986 p 720-727 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

**N87-27299#** Joint Publications Research Service, Arlington, Va.
**LIGHT PROPAGATION IN STRATIFIED MEDIUM WITH HIGHLY ANISOTROPIC SCATTERING Abstract Only**
V. S. Remizovich, D. B. Rogozkin, and M. I. Ryazanov *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 55 Transl. into ENGLISH from Izvestiya Akademii Nauk SSSR: Fizika Atmosfery i Okeana (Moscow, USSR), v. 22, no. 7, Jul. 1986 p 736-742 Original language document was announced in IAA as A87-15236 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

**N87-27301#** Joint Publications Research Service, Arlington, Va.
**IMPROVED METHOD FOR DETERMINING VERTICAL REFRACTION Abstract Only**
V. V. Vinogradov *In its* USSR Report: Earth Sciences 4 Dec.

1986 p 56-57 Transl. into ENGLISH from Geodeziya i Kartografiya (Moscow, USSR), no. 7, Jul. 1986 p 18-20 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

**N87-27302#** Joint Publications Research Service, Arlington, Va.
**SPECTRAL LIGHT SCATTERING COEFFICIENTS FOR ATMOSPHERIC SURFACE LAYER Abstract Only**
M. A. Derbisalin, G. Sh. Livshits, and O. D. Tokarev *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 57 Transl. into ENGLISH from Izvestiya Akademii Nauk SSSR: Fizika Atmosfery i Okeana (Moscow, USSR), v. 22, no. 6, Jun. 1986 p 588-594 Original language document was announced in IAA as A87-10379 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

**N87-27305#** Joint Publications Research Service, Arlington, Va.
**POSSIBILITY OF DETERMINING EFFECTIVE PROTON PAIR LENGTH IN CLOUDS IN IR SPECTRAL REGION USING CO2 ABSORPTION BAND 2.06 MICRON Abstract Only**
Ye. I. Grechko, S. V. Dvoryashin, and V. I. Dianov-Klokov *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 59-60 Transl. into ENGLISH from Izvestiya Akademii Nauk SSSR: Fizika Atmosfery i Okeana (Moscow, USSR), v. 22, no. 6, Jun. 1986 p 607-615 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

**N87-27306#** Joint Publications Research Service, Arlington, Va.
**VARIATIONS IN OPTICAL PROPERTIES OF STRATOSPHERIC AEROSOL Abstract Only**
M. S. Kiseleva *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 60 Transl. into ENGLISH from Izvestiya an SSSR: Fizika Atmosfery i Okeana (Moscow, USSR), v. 22, no. 5, May 1986 p 497-504 Original language document was announced in IAA as A86-49953 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

# 47 METEOROLOGY AND CLIMATOLOGY

Includes weather forecasting and modification.

**N87-27359*#** South Dakota School of Mines and Technology, Rapid City. Inst. of Atmospheric Sciences.
**INVESTIGATIONS INTO THE F-106 LIGHTNING STRIKE ENVIRONMENT AS FUNCTIONS OF ALTITUDE AND STORM PHASE Semiannual Progress Report, 15 Mar. - 14 Sep. 1986**
John H. Helsdon, Jr. 7 Jan. 1987 62 p
(Grant NAG1-463)
(NASA-CR-180292; NAS 1.26:180292) Avail: NTIS HC A04/MF A01 CSCL 04B

Work accomplished during this period centered on the completion of the first order parameterization scheme for the intracloud lightning discharge and its incorporation within the framework of the Storm Electrification Model (SEM). B.G.

**N87-27360*#** South Dakota School of Mines and Technology, Rapid City. Inst. of Atmospheric Sciences.
**ATMOSPHERIC ELECTRICAL MODELING IN SUPPORT OF THE NASA F106 STORM HAZARDS PROJECT Final Report, 15 Mar. 1984 - 14 Jun. 1987**
John H. Helsdon, Jr. Jun. 1987 134 p
(Grant NAG1-563)
(NASA-CR-181000; NAS 1.26:181000; SDSMT/IAS/R-87/02)
Avail: NTIS HC A07/MF A01 CSCL 04B

The effect of thunderstorm particles on lightning initiation was studied. A model was developed to roughly predict breakdown field as a function of particle size, density and shape. The resulting application of the model showed that only the largest particles may be expected to have much effect on the threshold initiation field. The effect of net change on the particles is to lower the effective breakdown field. An experimental criterion on the electric field gradient was applied to fields around thunderstorm particles. Once again, only the largest particles were seen to satisfy this criterion. Author

**N87-27361#** Wisconsin Univ., Madison. Dept. of Meteorology.
**MEASURING ATMOSPHERIC EXTINCTION AND BACKSCATTER WITH A HIGH SPECTRAL RESOLUTION LIDAR Final Report, 1 May 1984 - 30 Nov. 1986**
Edwin W. Eloranta and Christian J. Grund 25 Apr. 1987 103 p
(Contracts DAAG29-84-K-0069; N00014-85-K-0581)
(AD-A180622; ARO-21488.1-GS) Avail: NTIS HC A06/MF A01 CSCL 17I

The University of Wisconsin High Spectral Resolution Lindar (HSRL) is designed to make unambiguous, remote measurements of extinction cross sections and backscatter phase functions. This investigation was planned to observe the dependence of aerosol scattering properties on relative humidity. A series of observations was performed. These data showed the expected increase of scattering cross section with increases in relative humidity. In addition the measurements showed that the backscatter phase function appeared to be constant while the total scattering cross section varied. This was a puzzling result. Mean particle size in an aerosol haze should increase with relative humidity; Mie scattering calculations predict that the backscatter phase function is a function of the mean size. A careful analysis of the measurement confidence limits indicated that we could not eliminate calibration uncertainties. At this point we changed the focus of our effort from measurements to instrument improvements. GRA

**N87-27362#** Army Cold Regions Research and Engineering Lab., Hanover, N. H.
**EXTINCTION COEFFICIENT MEASUREMENT IN FALLING SNOW WITH A FORWARD SCATTER METER**
Gary Koh Mar. 1987 13 p
(AD-A180958; CRREL-SR-87-4) Avail: NTIS HC A02/MF A01 CSCL 20F

A forward scatter meter designed to measure the visible extinction coefficient in fog has been tested in falling snow. The comparison of the extinction coefficients measured with a forward scatter meter and a transmissometer indicates that a forward scatter meter can be used to measure extinction coefficient in falling snow. The different calibrations required for snow and fog are partially explained by examining the effect of particle size on the angular distribution of scattered light. GRA

**N87-27363#** Naval Postgraduate School, Monterey, Calif.
**SUPERPOSITION EFFECTS IN RAPID CYCLOGENESIS Ph.D. Thesis**
Larry L. Warrenfeltz Mar. 1987 174 p
(AD-A181606) Avail: NTIS HC A08/MF A01 CSCL 04A

The effects of the zonal and meridional superposition of finite amplitude upper and lower level perturbations are investigated using a two-level analytical model and the Navy Operational Regional Atmospheric Prediction System (NORAPS). The initial along stream phase difference is crucial to the subsequent intensification of the low level perturbation. A westward tilt with height of slightly less than a quarter wavelength is most favorable. The initial meridional superposition only modifies the growth rate established by the optimum zonal phase difference. The strength and location of the low-level baroclinity and upper level shear vorticity, which depend on the structure of the mean flow, are important factors in determining the most favorable cross track tilt. In the jet streak case with strong upper level forcing, the lower perturbation quickly moves to the most favored meridional position under the left front quadrant. An east coast cyclogenesis event during 19-21 January 1986 is used to illustrate the effects of superposition. Despite strong upper-level forcing, rapid cyclogenesis did not occur, because the optimum superposition between the upper-level vorticity center and the surface cyclone was not achieved. GRA

**N87-27364#** Naval Postgraduate School, Monterey, Calif.
**THE USE OF OBSERVED DATA FOR THE INITIAL VALUE PROBLEM IN NUMERICAL WEATHER PREDICTION Technical Report, Aug. 1986 - Apr. 1987**
Richard Franke, Edward Barker, and James Goerss Apr. 1987 43 p
(AD-A181744; NPS-53-87-002) Avail: NTIS HC A03/MF A01 CSCL 04B

The problem of combining observed and predicted values of meteorological variables, all with error, to obtain current weather conditions is considered. Statistical interpolation is in common use for this problem. Properties of isotropic spatial covariance functions are developed. The performance of several families of covariance functions in fitting published data is investigated. The second order autoregressive covariance function is identified as having suitable theoretical and excellent approximation properties. Sensitivity of the errors in statistical interpolation to misspecification of the statistical parameters is explored, showing that the process is quite stable to such perturbations. GRA

**N87-27365#** Naval Postgraduate School, Monterey, Calif.
**POTENTIAL OBSERVING SYSTEMS FOR TROPICAL CYCLONE MOTION STUDIES Interim Report, Oct. 1986 - Sep. 1987**
Russell L. Elsberry May 1987 49 p
(AD-A181745; NPS-63-87-003) Avail: NTIS HC A03/MF A01 CSCL 04B

A synopsis is presented of a workshop during April 1987 sponsored jointly by the Hurricane Research Division (HRD) of the National Oceanographic and Atmospheric Administration (NOAA) and the Marine Meteorology Section of the Office of Naval Research (ONR). The objective of the workshop was to exchange information and begin documentation of observational systems that can be used in tropical cyclone studies. HRD personnel described the objectives of their annual field program studies and ONR personnel described plans for a field experiment on tropical cyclone motion during 1989 or 1990. Potential observational systems that were presented include: space-based systems; dropwindsondes; airborne radar systems; remotely-sensed surface wind speed systems; rawinsondes; wind profilers; and surface observations with drifting buoys. Recent HRD efforts to objectively analyze observations in the region of hurricanes were also described. GRA

**N87-27366#** Naval Postgraduate School, Monterey, Calif.
**VERTICAL WIND SHEAR AS A PREDICTOR OF TROPICAL CYCLONE MOTION M.S. Thesis**
Denis H. Meanor Mar. 1987 75 p
(AD-A181818) Avail: NTIS HC A04/MF A01 CSCL 04B

The effects of vertical wind shear on tropical cyclone motion are investigated for 1357 western North Pacific Ocean cases. An empirical orthogonal function (EOF) analysis is used to represent the vertical shear of the zonal and meridional components between the 700, 400 and 250 mb levels. Composite wind-shear fields are developed for five past-motion storm categories and analyzed to determine their statistical differences. The significant differences between these categories represent differing synoptic forcing by the wind shear that affects storm motion. Within the category of storms moving northwest, significant differences occur between right- and left-turning cyclones. This demonstrates that the vertical shears derived from operationally analyzed wind fields contain synoptic forcing information that is revelant to tropical cyclone motion. A regression analysis is used to identify potential predictors from among the wind-shear EOF coefficients. These predictors are included in regression equations to post-process the 24-, 48- and 72-h OTCM (One-way Tropical Cyclone Model) forecasts for 1982 to 1983. The modified OTCM tracks using this scheme have an average error of 419 km and 72 h, which is an improvement of 174 and 212 km over the unmodified OTCM and official Joint Typhoon Warning Center 72 h forecast errors, respectively. GRA

**N87-27367** Minnesota Univ., Minneapolis.
**A STUDY OF THE ATMOSPHERIC ELECTRICAL CONDUCTIVITY AND RELATED ATMOSPHERIC PARAMETERS Ph.D. Thesis**
Jeffrey William Stein 1987 179 p
Avail: Univ. Microfilms Order No. DA8709572

A dissipation method was used to measure the atmospheric electrical polar conductivities on the roof of the physics building on the University of Minnesota campus in Minneapolis for a period of one year. The atmospheric electric field was measured at the same time using an electric field mill. One purpose of these measurements was to validate the dissipation method of conductivity determination being used by examining the weekly, seasonal, and diurnal variation of the conductivity, and comparing the results to those reported at other stations. Another goal was to see if any phase difference between the behavior of the polar electrical conductivities and that of the electric field could be established. The origin and relevance of such a phase difference is discussed. Dissert. Abstr.

**N87-27368#** National Weather Service, Garden City, N.Y.
**PROCEDURE FOR IMPROVING FIRST PERIOD MODEL OUTPUT STATISTICS PRECIPITATION FORECASTS**
A. J. Lacroix and J. A. Ronco Apr. 1987 18 p
(PB87-184149; NOAA-TM-NWS-ER-73) Avail: NTIS HC A02/MF A01 CSCL 04B

A technique is presented for using the 700 millibar trajectory from the National Meteorological Center (NMC) trajectory bulletin (FTJXX) to modify precipitation probability forecasts prepared at NMC from model output statistics. GRA

**N87-27369*#** General Electric Co., Huntsville, Ala. Automated Systems Dept.
**AUTOMATED MESOSCALE WINDS DETERMINED FROM SATELLITE IMAGERY Final Report**
Jun. 1987 54 p
(Contract NAS8-34596)
(NASA-CR-179150; NAS 1.26:179150; Rept-83HV002) Avail: NTIS HC A04/MF A01 CSCL 04B

A new automated technique for extracting mesoscale fields from GOES visible/infrared satellite imagery was developed. Quality control parameters were defined to allow objective editing of the wind fields. The system can produce equivalent or superior cloud wind estimates compared to the time consuming manual methods used on various interactive meteorological processing systems. Analysis of automated mesoscale cloud wind for a test case yields an estimated random error value one meter per second and produces both regional and mesoscale vector wind field structure and divergence patterns that are consistent in time and highly correlated with subsequent severe thunderstorm development. Author

**N87-27370#** World Meteorological Organization, Geneva (Switzerland).
**MANUAL FOR ESTIMATION OF PROBABLE MAXIMUM PRECIPITATION, SECOND EDITION**
1986 299 p
(WMO-332; OH-1; ISBN-92-63-11332-2; ETN-87-90059)
Copyright Avail: NTIS MF A01; print copy available at WMO, Geneva, Switzerland SWFR 33

Meteorological approaches for estimating probable maximum precipitation in midlatitude orographic and nonorographic regions for areas up to 50,000 sq km are given. Procedures and concepts which can be used to adapt the applicable procedures to tropical regions are described. ESA

**N87-27371#** World Meteorological Organization, Geneva (Switzerland).
**[ACTIVITIES REPORT IN METEOROLOGY] Annual Report, 1986**
1987 251 p
(WMO-676; ISBN-92-63-10676-2; ETN-87-90061) Copyright Avail: NTIS MF A01; print copy available at WMO, Geneva, Switzerland

Avail: NTIS MF A01; print copy available at WMO, Geneva, Switzerland

The activities of the World Meteorological Organization's World Weather Watch; World Climate; Research and Development; Applications of Meteorology; Hydrology and Water Resources; Education and Training; Technical Cooperation, and Regional Activities programs are summarized. ESA

**N87-27372#** International Meteorological Inst., Stockholm (Sweden).
**[ACTIVITIES REPORT IN METEOROLOGY] Annual Report, Jul. 1985 - Jun. 1986**
Dec. 1986 52 p
(AR-85-86; ISSN-0349-0068; ETN-87-90076) Avail: NTIS HC A04/MF A01

Research concerning models of planetary/synoptic wave interactions; blocking; condensation and clouds in numerical models; hysteritic effects and scale selection in moist convection: entrainment; convection; chemical meteorology and biogeochemistry; aerosols; and aeronomy is summarized. ESA

**N87-27284#** Joint Publications Research Service, Arlington, Va.
**MODEL OF WORLD OCEAN CLIMATE Abstract Only**
M. Ya. Verbitskiy and D. V. Chalikov *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 18 Transl. into ENGLISH from Okeanologiya (Moscow, USSR), v. 26, no. 3, May - Jun. 1986 p 357-364 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

**N87-27294#** Joint Publications Research Service, Arlington, Va.
**SIMULATION OF MODERN CLIMATE BASED ON OCEAN-ATMOSPHERE-ICE SYSTEM Abstract Only**
M. Ya. Verbitskiy and D. V. Chalikov *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 37-38 Transl. into ENGLISH from Izvestiya an SSSR: Fizika Atmosfery i Okeana (Moscow, USSR), v. 22, no. 5, May 1986 p 458-467 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

**N87-27297#** Joint Publications Research Service, Arlington, Va.
**ATMOSPHERIC FRONT PRECIPITATION INTENSITY SPECTRA Abstract Only**
A. A. Lyakhov and N. P. Shakina *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 53 Transl. into ENGLISH from Izvestiya Akademii Nauk SSSR: Fizika Atmosfery i Okeana (Moscow, USSR), v. 22, no. 7, Jul. 1986 p 712-719 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

**N87-27300#** Joint Publications Research Service, Arlington, Va.
**VARIABILITY OF TEMPERATURE FLUCTUATION SPECTRA IN ATMOSPHERIC BOUNDARY LAYER Abstract Only**
V. A. Bezverkhniy, A. S. Gurvich, and V. P. Kukharets *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 55-56 Transl. into ENGLISH from Izvestiya Akademii Nauk SSSR: Fizika Atmosfery i Okeana (Moscow, USSR), v. 22, no. 7, Jul. 1986 p 675-681 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

**N87-27303#** Joint Publications Research Service, Arlington, Va.
**USE OF SPHERICAL HARMONICS IN DETERMINING RADIATION TRANSFER IN BROKEN CLOUDS Abstract Only**
T. B. Zhuravleva and G. A. Titov *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 58 Transl. into ENGLISH from Izvestiya Akademii Nauk SSSR: Fizika Atmosfery i Okeana (Moscow, USSR), v. 22, no. 6, Jun. 1986 p 600-606 Original language document was announced in IAA as A87-10381 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

**N87-27304#** Joint Publications Research Service, Arlington, Va.
**GIANT AEROSOL CLOUDS STUDIED WITH AIRBORNE LASER COMPLEX Abstract Only**
L. Levitskiy *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 58-59 Transl. into ENGLISH from Izvestiya (Moscow, USSR) 8 Aug. 1986 p 3 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

# 48 OCEANOGRAPHY

Includes biological, dynamic, and physical oceanography; and marine resources.

For related information see also *43 Earth Resources and Remote Sensing.*

**N87-27373#** Army Cold Regions Research and Engineering Lab., Hanover, N. H.
**MECHANICAL PROPERTIES OF MULTI-YEAR SEA ICE. PHASE 1: ICE STRUCTURE ANALYSIS**
Jacqueline A. Richter-Menge, Gordon F. Cox, and Nancy M. Perron Mar. 1987 36 p
(AD-A181205; CRREL-87-3) Avail: NTIS HC A03/MF A01 CSCL 08L

This report describes the structural analysis of multi-year sea ice samples that were tested in the first phase of a program designed to obtain a comprehensive understanding of the mechanical properties of multi-year sea ice from the Alaskan Beaufort Sea. Each test specimen is classified into one of three major ice texture categories: granular columnar, or a mixture of columnar and granular ice. The crystallographic orientation, percent columnar ice, and grain size are then evaluated for the granular and/or columnar ice in the sample. Test results are interpreted with respect to these parameters. The overall composition of multi-year ridges is also considered, based on the extensive field sampling that was done in the program. GRA

**N87-27374#** Naval Postgraduate School, Monterey, Calif.
**A HORIZONTAL SPATIAL REQUIREMENT STUDY OF THE GULF STREAM AS MODELLED BY THE IFDPE (IMPLICIT FINITE DIFFERENCE PARABOLIC EQUATION) ACOUSTIC MODEL M.S. Thesis**
Katherine L. Cease Mar. 1987 144 p
(AD-A181375) Avail: NTIS HC A07/MF A01 CSCL 20A

The sampling increment in horizontal spacing for a range-dependent environment was studied with respect to accurate prediction of propagation loss through a frontal system. A transmission loss model was verified by comparing its predictions with experimental data when the sampling increment was very small. A study of the effect of altering the sampling increment produced a maximum increment which retained a reasonable agreement with the prediction for very small incrementation. Sensitivity studies were performed at three source depths to determine depth dependency. GRA

**N87-27375#** Scripps Institution of Oceanography, La Jolla, Calif.
**SCRIPPS OCEAN MODELING AND REMOTE SENSING (SOMARS) Semiannual Progress Report no. 1**
William A. Nierenberg, Catherine Gautier, James J. Simpson, Richard C. Somerville, and Geoffrey K. Vallis 14 Apr. 1987 31 p
(AD-A181382) Avail: NTIS HC A03/MF A01 CSCL 08C

This is a semi-annual report based on the activities of 10 research groups: (1) Development for the Mercury Array processor for advanced image processing; (2) The use of synthetic aperture radar for studying ocean waves and wave current interactions; (3) The study of wind sets on the North Pacific Ocean; (4) Development of a Kalman filtering spectral Analysis Program; (5) Acquisition of a VAX-11/750 to study Marine Climatology and Ocean Currents; (6) The reduction of Lagrangian drifter data for the California current; (7) Integration of on-site and remote sensing data for the study of marine systems; (8) The study of the mixed layer model of the ocean; (9) Experiments on the assimilation of altimeter data into a quasi-geostrophic, eddy resolving numerical model; and (10) Data assimilation on basin scaling modeling. GRA

**N87-27376#** Marine Research Inst., Helsinki (Finland).
**INVESTIGATION OF ICE DYNAMICS IN THE MARGINAL ICE ZONE Final Technical Report, Jan. 1983 - Apr. 1986**
Matti Leppaeranta and William D. Hibler, III 23 Apr. 1987 116 p
(Contract DAJA45-83-C-0034; DA Proj. 1L1-61102-BH-57)
(AD-A181392; R/D-5196-EN-01) Avail: NTIS HC A06/MF A01 CSCL 08L

The dynamics of sea ice in the marginal ice zone (MIZ) are considered both from theoretical and from experimental point of view. Ice kinematics measurements were made with the Del Norte microwave trisponder system in MIZEX-83 and MIZEX-84 Greenland Sea experiments. Differential ice motion was measured with four to six stations on the ice in the scale of 2 to 20 km at three minute intervals. On several occasions a rapid slip occurred in measured distances. Ice velocity fluctuations were typically of the order of 1 cm/s and large deformation rates a few per cent/hour. Various spectra of differential ice drift showed a moderate inertial peak and a red noise character at higher frequencies, up to about half-hour period. The maximum rate of shear was about twice as large as divergence from 12-h to about 2-h period. Analysis of current measurements beneath the drifting ice show that current variations show up highly damped in the ice. In differential motion, ice-current coherence was significant only at low frequencies (lower than one cycle per day). GRA

**N87-27377#** Scripps Institution of Oceanography, La Jolla, Calif. Physical and Chemical Oceanographic Data Facility.
**PACIFIC THERMOCLINE CIRCULATION STUDY Report, 30 Jun. - 4 Aug. 1983**
Peter P. Niiler Nov. 1986 113 p
(Contract N00014-80-C-0440; Grant NSF OCE-82-17915)
(AD-A181446; SIO-REF-86-27; PACODF-PUB-220) Avail: NTIS HC A06/MF A01 CSCL 08C

From July 1982 to October 1985, two current meter moorings were deployed in the northeastern Pacific at 42 deg N and 28 deg N, 152 deg W. Between six and ten vector-averaging current meters and Aanderaas were placed on each taut-wire sub-surface mooring, and these were exchanged about every twelve months. The purpose was to measure the vertical and temporal structure of low-frequency motions in the eastern Pacific basin. To interpret the current meter data in terms of dynamic principles, the vertical structure of the density gradient in the entire water column is required. Current meters measure only the temperature. In July 1983, a CTD survey was carried out in support of the mooring program during the redeployment cruise of the moorings. A 600 km equatorial, triangular pattern of stations was occupied around each mooring, with CTD casts from the surface to the ocean floor. Interspersed with the CTD stations were 1700m XBT stations (Sippican model T-5). Three XBT-CTD calibration stations were also done. The CTD data are presented in this reports. GRA

**N87-27378#** California Univ., Davis. Dept. of Geology.
**[LONG-TERM EVOLUTION OF THE OCEANIC CRUST] Final Technical Report**
James S. McClain 1986 21 p
(Contract N00014-81-K-0457)
(AD-A181495) Avail: NTIS HC A02/MF A01 CSCL 08G

The initial work on this contract was to analyze Project ROSE data, and to invert it for the three dimensional structure of the oceanic crust under the East Pacific Rise. We developed a substantial amount of software for the handling of seismic data. Later work sought to obtain a better understanding of the long-term evolution of the oceanic crust. We proposed to gather data for a seismic transect of the Pacific Ocean spanning ages of 0 to 60 million years. The data we used was from a series of seismic refraction profiles that were conducted in the 1950s. We digitized data from 7 profiles and have analyzed these profiles. Results show that any long-term evolution of the crust in the Pacific is small compared to the normal variability of the structure created when it is formed at the mid-ocean ridges. Of particular importance, we showed that thickening of the oceanic crust was relatively minor, which contradicts a number of earlier studies that indicated substantial thickening of the crust as it aged. GRA

**N87-27379#** Coastal Engineering Research Center, Vicksburg, Miss.
**TSUNAMI PREDICTIONS FOR THE COAST OF ALASKA: KODIAK ISLAND TO KETCHIKAN Final Report, May 1985 - Jul. 1986**
Peter L. Crawford Apr. 1987 137 p
(AD-A181775; CERC-TR-87-7) Avail: NTIS HC A07/MF A01 CSCL 08C

The 100- and 500-year combined tsunami and tide elevations were predicted at sites along the coast of Alaska between Kodiak Island and Ketchikan. Lack of historical data at most sites necessitated the generation of a synthetic record of tsunami activity in the Gulf of Alaska. The geophysical and tectonic setting of the Gulf were used to synthesize a record of tsuamigenic, tectonic deformations of the seafloor. A numerical model was used to simulate the tsunamis resulting from each deformation. Numerical simulations of the 1964 Alaskan tsunami were made and compared with historical tide gage recordings. Historical data of tsunami activity along the entire Aleutian trench were used to assign probability of occurrence to each tsunami in the synthetic record. A numerical procedure was used to combine the effects of astronomical tides and tsunamis and to produce to 100- and 500-year combined tsunami and tide elevations. Author (GRA)

**N87-27283#** Joint Publications Research Service, Arlington, Va.
**BOUNDARY VALUE PROBLEM FOR SEA SURFACE TOPOGRAPHY IN SEA CURRENT MODELS Abstract Only**
Yu. L. Demin and R. A. Ibrayev *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 17-18 Transl. into ENGLISH from Izvestiya Akademii Nauk SSSR: Fizika Atmosfery i Okeana (Moscow, USSR), v. 22, no. 7, Jul. 1986 p 757-764 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

**N87-27286#** Joint Publications Research Service, Arlington, Va.
**PREDICTION OF SYNOPTIC MOVEMENTS IN POLYMODE REGION USING BAROTROPIC MODEL Abstract Only**
V. M. Kamenkovich, Yu. M. Grachev, and B. V. Kharkov *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 19-20 Transl. into ENGLISH from Okeanologiya (Moscow, USSR), v. 26, no. 3, May - Jun. 1986 p 376-381 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

**N87-27287#** Joint Publications Research Service, Arlington, Va.
**QUASIGEOSTROPHIC THREE-LAYER MODEL OF HYDRODYNAMIC INSTABILITY OF CURRENTS FOR INVESTIGATING EDDY FORMATION CONDITIONS IN WORLD OCEAN Abstract Only** **c48**
A. S. Blatov, N. S. Rapilbekova, and V. I. Ulyanova *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 21 Transl. into ENGLISH from Okeanologiya (Moscow, USSR), v. 26, no. 3, May - Jun. 1986 p 389-394 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

**N87-27288#** Joint Publications Research Service, Arlington, Va.
**SPATIAL VARIABILITY OF THERMAL STRUCTURE OF OCEAN ACTIVE LAYER DURING PASSAGE OF SYNOPTIC EDDIES Abstract Only**
B. N. Filyushkin *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 22 Transl. into ENGLISH from Okeanologiya (Moscow, USSR), v. 26, no. 3, May - Jun. 1986 p 395-401 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

**N87-27289#** Joint Publications Research Service, Arlington, Va.
**MAGNETIC CHARACTERISTICS OF DEEP LAYERS OF OCEANIC CRUST AND STRUCTURE OF ANOMALOUS MAGNETIC FIELD IN OCEAN Abstract Only**
Ye. A. Nazarova and A. M. Gorodnitskiy *In its* USSR Report:

Earth Sciences 4 Dec. 1986 p 24 Transl. into ENGLISH from Okeanologiya (Moscow, USSR), v. 26, no. 3, May - Jun. 1986 p 446-450 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

**N87-27290#** Joint Publications Research Service, Arlington, Va.
**SEDIMENTARY STRUCTURE OF CENTRAL BASIN IN PACIFIC OCEAN Abstract Only**
G. A. Semenov, O. V. Levchenko, V. N. Moskalenko, and P. N. Kuzmin *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 24-25 Transl. into ENGLISH from Okeanologiya (Moscow, USSR), v. 26, no. 3, May - Jun. 1986 p 451-459 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

**N87-27291#** Joint Publications Research Service, Arlington, Va.
**DEEP SEISMIC SOUNDING OF SUBCRUSTAL LITHOSPHERE IN SOUTH ATLANTIC Abstract Only**
S. M. Zverev, G. A. Yaroshevskaya, Yu. V. Tulina, G. A. Krasilshchikova, N. M. Nardov, V. M. Shablitskiy, O. A. Beresnev, V. K. Illarionov, and N. A. Pavlenkova *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 32-33 Transl. into ENGLISH from Doklady Akademii Nauk SSSR (Moscow, USSR), v. 289, no. 2, Jul. 1986 p 322-327 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

**N87-27293#** Joint Publications Research Service, Arlington, Va.
**CALCULATION OF EARTH-MOON SYSTEM TIDAL EVOLUTION BASED ON MATHEMATICAL MODEL OF TIDES IN PALEO-OCEAN Abstract Only**
Ye. V. Polyakov *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 37 Transl. into ENGLISH from Izvestiya an SSSR: Fizika Atmosfery i Okeana (Moscow, USSR), v. 22, no. 5, May 1986 p 505-512 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

**N87-27295#** Joint Publications Research Service, Arlington, Va.
**FREQUENCY SPECTRA OF OCEAN SURFACE TEMPERATURE ANOMALIES Abstract Only**
L. I. Piterbarg *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 38 Transl. into ENGLISH from Izvestiya an SSSR: Fizika Atmosfery i Okeana (Moscow, USSR), v. 22, no. 3, Mar. 1986 p 301-309 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

**N87-27296#** Joint Publications Research Service, Arlington, Va.
**VOLCANIC-TECTONIC MODEL OF OCEAN FORMATION Abstract Only**
A. Ye. Svyatlovskiy *In its* USSR Report: Earth Sciences 4 Dec. 1986 p 50 Transl. into ENGLISH from Vulkanologiya i Seysmologiya (Moscow, USSR), no. 3, May - Jun. 1986 p 3-11 (For primary document see N87-27281 21-42)
Avail: NTIS HC A05/MF A01

# 51 LIFE SCIENCES (GENERAL)

**N87-27380#** Pennsylvania State Univ., University Park. Cooperative Program in Biotechnology.
**SYMPOSIUM AND WORKSHOP SUPPORT IN MOLECULAR BIOLOGY AND BIOTECHNOLOGY (5TH) HELD IN UNIVERSITY PARK, PENNSYLVANIA ON FEBRUARY 5, 1986 AND JULY 30 - AUGUST 1, 1986 Final Technical Report, 1 Sep. 1985 - 28 Feb. 1987**
S. E. Stevens, Jr. 29 Apr. 1987 25 p Symposium held in University Park, Pa., 5 Feb. and 30 Jul. - 1 Aug. 1986
(Grant AF-AFOSR-0338-85)
(AD-A181190; AFOSR-87-0714TR) Avail: NTIS HC A02/MF A01 CSCL 06B

The Cooperative Program in Biotechnology held the Fifth Winter Workshop, the Fifth Summer Symposium in Molecular Biology and will present the Sixth Summer Symposium in Molecular Biology in 1987 under the auspices of the AFOSR. The Fifth Winter Workshop was an open meeting without registration and was attended by about 200 people. This paper consists of a schedule of events and a pre-registration list. GRA

# 52 AEROSPACE MEDICINE

Includes physiological factors; biological effects of radiation; and effects of weightlessness on man and animals.

**N87-27381*#** Rockefeller Univ., New York.
**VESTIBULAR SYSTEM AND NEURAL CORRELATES OF MOTION SICKNESS Final Technical Report, 1 Mar. 1982 - 28 Feb. 1986**
Alan D. Miller 28 Feb. 1986 7 p
(Grant NAG2-164)
(NASA-CR-181185; NAS 1.26:181185) Avail: NTIS HC A02/MF A01 CSCL 06P

Initial studies re-examine the role of certain central nervous system structures in the production of vestibular-induced vomiting and vomiting in general. All experiments were conducted using cats. Since these studies demonstrated that the essential role of various central structures in vestibular-induced vomiting is only poorly understood, efforts were re-directed to study the control of the effector muscles (diaphragm and abdominal muscles) that produce the pressure changes responsible for vomiting, with the goal of determining how this control mechanism is engaged during motion sickness. Experiments were conducted to localize the motoneurons that innervate the individual abdominal muscles and the portion of the diaphragm that surrounds the esophagus. A central question regarding respiratory muscle control during vomiting is whether these muscles are activated via the same brain stem pre-motor neurons that provide descending respiratory drive and/or by other descending input(s). In other experiments, the use of a combination of pitch and roll motions to produce motion sickness in unrestrained cats was evaluated. This stimulus combination can produce vomiting in only the most susceptible cats and is thus not as provacative a stimulus for cats as vertical linear acceleration. Author

**N87-27382#** Army Research Inst. of Environmental Medicine, Natick, Mass.
**MAUNA KEA 3: METABOLIC EFFECTS OF DIETARY CARBOHYDRATE SUPPLEMENTATION DURING EXERCISE AT 4100 M ALTITUDE Final Report, Jul. 1985 - Apr. 1987**
E. W. Askew, J. W. Claybaugh, G. M. Hashiro, W. S. Stokes, and A. Sato 1 May 1987 91 p
(AD-A180629; USARIEM-T-12-87) Avail: NTIS HC A05/MF A01 CSCL 06J

Twenty-nine male soldiers were divided into 3 groups to study the effects of exercise and carbohydrate supplementation on physical performance and metabolism at high altitude. All groups were provided a standard military field ration (Meal, Ready-to-Eat) containing 45% carbohydrate (CHO) was consumed ad libitum during 4 consecutive days of residence at an altitude of 4100 M. Two groups (EX and EX + CHO) exercised while at high altitude by running and walking at about 75% maximum heart rate 2h/day. The third group (SED) remained sedentary while at high altitude. One exercise group (EX + CHO) was permitted to consume carbohydrate sweetened beverages ad libitum as a supplement (250 to 350 g CHO/day) to the diet. The other two groups consumed similar beverages containing a non-caloric sweetener also on an ad libitum basis. Baseline measurements of food consumption, aerobic capacity, and blood and urine metabolites were recorded for all groups during 2 days of sedentary activity at sea level prior to rapid ascent to altitude (4100 M). Mean daily caloric intakes during the 4 days of exercise at altitude were 1513 kcal (SED), 1787 kcla (EX), and 2325 kcal (EX+CHO). The EX+CHO group consumed an average of 404 g CHO/day compared to 187 and 159 g CHO/day for the EX and SED groups respectively. GRA

**N87-27383#** Federal Aviation Administration, Washington, D.C. Office of Aviation Medicine.
**A STUDY OF PASSENGER WORKLOAD AS RELATED TO PROTECTIVE BREATHING REQUIREMENTS Final Report**
E. A. Higgins, J. T. Saldivar, P. J. Lyne, and G. E. Funkhouser Mar. 1987 75 p
(AD-A181089; DOT/FAA/AM-87/2) Avail: NTIS HC A04/MF A01 CSCL 06N

This study was undertaken to evaluate workloads, oxygen consumption, carbon dioxide production and respiratory exchange rates for passengers during an emergency aircraft evacuation. This was accomplished in an effort to formulate possible qualification standards for a passenger protective breathing device intended to protect from smoke and fumes. GRA

**N87-27384#** Stanford Univ., Calif. Dept. of Psychology.
**PROPERTIES AND CONSEQUENCES OF VISUAL PERSISTENCE Final Report, 1 Sep. 1984 - 30 Jun. 1986**
Michael Pavel 18 Feb. 1987 12 p
(Grant AF-AFOSR-0308-84)
(AD-A181139; AFOSR-87-0713TR) Avail: NTIS HC A02/MF A01 CSCL 05H

The major effort in our laboratory was directed to investigating the ability of subjects to represent and use visual spatial location. One series of experiments was concerned with the effects of expectation of events (stimuli) at different spatial locations, on the performance of observers in different type of tasks. The results indicate that attentional effects (change in sensitivity) depend on the attentional instructions as well as on the complexity of the tasks. Another series of studies was carried out to assess the accuracy of perceived relative location as a function of visual yield eccentricity. The goal was to determine to what extend can human pattern recognition abilities be characterized as a translation invariant (after appropriate scaling) system. The results indicate that, although translation invariance does not hold, there are regularities in the data that give rise to interesting models of visual representation of distances. Another series of experiments was carried out to determine how people judge the direction of motion and how accurately they predict the final location of a moving target. The somewhat surprising results indicate that the judgement of moving targets yield similar accuracy as those with static stimuli. GRA

**N87-27385#** Army Aeromedical Research Lab., Fort Rucker, Ala.
**LOW ALTITUDE, HIGH SPEED PERSONNEL PARACHUTING: MEDICAL AND PHYSIOLOGICAL ISSUES Final Report**
David J. Wehrly Feb. 1987 26 p
(AD-A181199; USAARL-87-3) Avail: NTIS HC A03/MF A01 CSCL 06J

This report reviews the medical and physiological issues in high speed, low altitude parachuting. Accident and experimental data are reviewed. The dearth of experimental/operational data related to these issues is noted. GRA

**N87-27386#** Rochester Univ., N. Y. Center for Visual Science.
**COMPUTATIONAL MODELS IN HUMAN VISION SYMPOSIUM (15TH) HELD ON JUNE 19-21, 1986 IN ROCHESTER, NEW YORK Final Report, 1 Feb. - 31 Mar. 1987**
Mary M. Hayhoe and Jerome Feldman 31 Mar. 1987 168 p
Symposium held in Rochester, N.Y., 19-21 Jun. 1986
(Grant AF-AFOSR-0118-86)
(AD-A181270; AFOSR-87-0607TR) Avail: NTIS HC A08/MF A01 CSCL 06D

This is a collection of abstracts and papers from a symposium on Computational Models in Human Vision held at the Center for Visual Science in June of 1986. Recently, a number of significant contributions to understanding human vision have come from the field of Artificial Intelligence. This influence is changing the scope and nature of the study of vision. The aim of the symposium was to crystallize this trend for the community of visual scientists, to review its contribution to the study of human vision, and to promote communication between vision scientists in neurophysiology, psychophysics, perception and computer vision. Papers were presented on: motion, color, texture, shape and form, space, and contextual effects and attention. These are all areas in which there has been significant computational work, and the abstracts in this collection reflect the current state of the field. GRA

**N87-27387#** Boston Univ., Mass. Center for Adaptive Systems.
**PERCEPTUAL DYNAMICS, REAL-TIME IMAGE PROCESSING, AND NEURAL ARCHITECTURES Final Report, 1 Feb. 1985 - 31 Jan. 1987**
Stephan Grossberg 20 May 1987 32 p
(Grant AF-AFOSR-0149-85)
(AD-A181295; AFOSR-87-0724TR) Avail: NTIS HC A03/MF A01 CSCL 06K

Annotated bibliography of research articles published during this project pertaining to a neural architecture for pattern recognition (Adaptive Resonance Theory); a model of pre-attentive vision (the boundary + feature contour systems): application of art to speech recognition; and models of attentional control of low-level sensory representations. GRA

**N87-27388#** Michigan Univ., Ann Arbor. Dept. of Physiology.
**CIRCADIAN VARIATION IN HOST DEFENSE Final Report, Nov. 1984 - Mar. 1987**
Matthew J. Kluger 21 May 1987 5 p
(Contract N00014-85-K-0027; Proj. RR0-4108)
(AD-A181319) Avail: NTIS HC A02/MF A01 CSCL 06D

The circadian rhythm in body temperature is thought to be due to a rhythm in the thermoregulatory set-point . The overall goal of our research was to determine whether this represents a circadian fever. If this hypothesis is correct, then antipyretic drugs should attenuate the rhythm in body temperature. We have found that administration of a variety of antipyretic drugs to rats markedly reduced their nighttime elevation in body temperature. These data suggest to us that prostaglandins are probably involved in the circadian rhythm in body temperature. We have attempted to determine whether this rhythm in prostaglandins is dependent on a rhythm in circulating concentrations of interleukin-1 (IL-1). Based on studies with rats and human beings using bioassays and immunoassays, we have been unable to detect any rhythm in plasma concentration of IL-1. We conclude that it is unlikely that circulating IL-1 has a role in the rhythm in body temperature. If IL-1 influences the circadian rhythm in body temperature, it may do so at the level of the hypothalamus or at some other central nervous site. GRA

**N87-27389#** Illinois Univ., Urbana-Champaign. Inst. of Aviation.
**THE EFFECTS ON PILOT PERFORMANCE OF ANTIEMETIC DRUGS ADMINISTERED SINGLY AND IN COMBINATION Final Report, Feb. 1983 - May 1985**
Henry L. Taylor, John A. Dellinger, Martha H. Weller, Bruce C. Richardson, and Fred C. Hyman Mar. 1987 12 p
(Contract F33615-83-K-0612)
(AD-A181549; USAFSAM-TR-85-99) Avail: NTIS HC A02/MF A01 CSCL 06O

Four experiments were conducted to evaluate the effects on human performance of alcohol and antiemetic drugs. In Experiment 1, the effects on pilot performance of 4 blood alcohol levels (BAL) were investigated to determine the sensitivity of the methodology. Experiment 2 evaluated the effects on pilot performance in a flight simulator of prescribed dosages of thiethylperazine (10 mg), promethazine hydrochloride (25 mg), cimetidine (300 mg), and a placebo control. Two tasks, a two-dimensional tracking task which is part of an instrument landing system (ILS) approach and the Sternberg Memory Search task, were used to generate pilot performance data. In Experiment 3 the effects of combinations of antiemetic drugs were investigated. Two additional flight task dependent variables, turning rate control while straight and level and while turning were added. Experiment 4 evaluated the effects of alcohol on pilot performance; the results were compared with the performance degradations resulting from combinations of antiemetic drugs. The results indicated that 0.12 percent BAL produced a decrement in pilot simulator instrument flight

performance. In comparison with the PTC effects, the high BAL produced a relatively larger performance decrement than the PTC combination. GRA

**N87-27390#** Los Alamos National Lab., N. Mex.
**A LAYERED NETWORK MODEL OF SENSORY CORTEX**
B. J. Travis 1986 50 p Presented at the 3rd International Conference on Computer Simulations in Brain Science, Copenhagen, Denmark, 1 Aug. 1986
(Contract W-7405-eng-36)
(DE87-008998; LA-UR-87-1275; CONF-8608178-1) Avail: NTIS HC A03/MF A01

An integrated computational approach to modeling sensory systems which couples realistic layered neural models of sensory cortex and midbrain nuclei to detailed models of the sense organs (e.g., retina or cochlea) is described. The approach is applied to the auditory system. Through an exercise of the model, it is shown that spatial location of sounds may be a natural consequence of the way cochlear response is mapped onto the cortex. DOE

**N87-27391#** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).
**AGARD GUIDE TO AEROSPACE AND DEFENCE TECHNICAL REPORT SERIES IN NATO COUNTRIES**
May 1987 348 p
(AGARD-R-743; ISBN-92-835-1549-8) Copyright Avail: NTIS HC A15/MF A01

A guide is presented to technical reports series relating to aerospace and defence research and development currently published by governments, contractors, research laboratories or universities in NATO member countries. The guide lists reports series from Belgium, France, the Federal Republic of Germany, the Netherlands, Norway, the United Kingdom, the United States and international organizations. Information given includes a technical report series code, a title (where available), name and address of the organization producing the series, availability (where known), type of organization and other helpful information provided by the producers. Two indexes are provided: an overall one by number; and one by number within country Author

**N87-27392*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
**QUALITY REQUIREMENTS FOR RECLAIMED/RECYCLED WATER**
Daniel S. Janik (National Academy of Sciences - National Research Council, Houston, Tex.), Richard L. Sauer, Duane L. Pierson, and Yvonne R. Thorstenson Mar. 1987 35 p
(NASA-TM-58279; S-559; NAS 1.15:58279) Avail: NTIS HC A03/MF A01 CSCL 06K

Water used during current and previous space missions has been either carried or made aloft. Future human space endeavors will require some form of water reclamation and recycling. There is little experience in the U.S. space program with this technology. Water reclamation and recycling constitute engineering challenges of the broadest nature that will require an intensive research and development effort if this technology is to mature in time for practical use on the proposed U.S. Space Station. In order for this to happen, reclaimed/recycled water specifications will need to be devised to guide engineering development. Present NASA Potable Water Specifications are not applicable to reclaimed or recycled water. Adequate specifications for ensuring the quality of the reclaimed or recycled potable water system is reviewed, limitations of present water specifications are examined, world experience with potable water reclamation/recycling systems and systems analogs is reviewed, and an approach to developing pertinent biomedical water specifications for spacecraft is presented. Space Station water specifications should be designed to ensure the health of all likely spacecraft inhabitants including man, animals, and plants. Author

**N87-27393*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
**THE EFFECT OF EXERCISE ON VENOUS GAS EMBOLI AND DECOMPRESSION SICKNESS IN HUMAN SUBJECTS AT 4.3 PSIA**
Johnny Conkin, James M. Waligora, David J. Horrigan, Jr., and Arthur T. Hadley, III Mar. 1987 21 p
(Contract NAS9-17200)
(NASA-TM-58278; S-558; NAS 1.15:58278) Avail: NTIS HC A02/MF A01 CSCL 06P

The contribution of upper body exercise to altitude decompression sickness while at 4.3 psia after 3.5 or 4.0 hours of 100% oxygen prebreathing at 14.7 psia was determined by comparing the incidence and patterns of venous gas emboli (VGE), and the incidence of Type 1 decompression sickness (DCS) in 43 exercising male subjects and 9 less active male Doppler Technicians (DT's). Each subject exercised for 4 minutes at each of 3 exercise stations while at 4.3 psia. An additional 4 minutes were spent monitoring for VGE by the DT while the subject was supine on an examination cot. In the combined 3.5 and 4.0 hour oxygen prebreathe data, 13 subjects complained of Type 1 DCS compared to 9 complaints from DT's. VGE were detected in 28 subjects compared to 14 detections from DT's. A chi-square analysis of proportions showed no statistically significantly difference in the incidence of Type 1 DCS or VGE between the two groups; however, the average time to detect VGE and to report Tyep 1 DCS symptoms were statistically different. It was concluded that 4 to 6 hours of upper body exercise at metabolic rates simulating EVA metabolic rates hastens the initial detection of VGE and the time to report Type 1 DCS symptoms as compared to DT's. Author

**N87-27394#** Nancy Univ. (France).
**THE SPACE ADAPTATION SYNDROME Ph.D. Thesis [LE SYNDROME DADAPTATION A LESPACE]**
Veronique Didier 1987 119 p In FRENCH
(ETN-87-90120) Avail: NTIS HC A06/MF A01

The space syndrome, the physiological effects of spacecraft life on the human body, and aspects of weightless environments are discussed. The inner ear equilibrium is analyzed. Treatment and prevention practices are described. It is concluded that it is a minor factor in the space adventure, not really dangerous, but a major handicap for manned space flight. ESA

# 53 BEHAVIORAL SCIENCES

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

**N87-27395#** Systems Research Labs., Inc., Dayton, Ohio.
**A COMPARISON OF TRACKING PERFORMANCE DURING GY STRESS BETWEEN TEST PILOTS AND PANEL SUBJECTS Technical Report, Jul. 1981 - Aug. 1982**
John W. Frazier, Daniel W. Repperger, Robert E. VanPatten, and Charles D. Goodyear Mar. 1987 19 p
(Contracts F33615-81-C-0500; F33615-83-C-0502)
(AD-A181080; AAMRL-TR-87-018) Avail: NTIS HC A02/MF A01 CSCL 01B

Seven centrifuge subjects and three AFTI/F-16 test pilots have participated in performance measuring experiments conducted on the Dynamic Environment Simulator (DES), a man-rated centrifuge. The primary task was a computer generated roll axis pursuit tracking task. The secondary task was to maintain the status quo of airspeed, altitude, pitch, and yaw. Test conditions included plus and minus 1.0, 1.25, 1.5, 1.75, and 2.0 Gy both with a standard restraint harness and with additional lateral support provided by shoulder pads. For all Gy conditions the secondary task was 9% better. These differences were not statistically significant. Both groups performed better when the shoulder pads (improved restraint system) were used. The standard restraint harness was rated inadequate at levels greater than 1.5 Gy. GRA

**N87-27396#** Pennsylvania Univ., Philadelphia.
**DIRECT ACCESS BY SPATIAL POSITION IN VISUAL MEMORY. PART 2: VISUAL LOCATION PROBES Technical Report, 1 Sep. 1985 - 31 Aug. 1987**
Saul Sternberg, Ronald L. Knoll, and David L. Turock 31 Dec. 1986 96 p
(Contracts N00014-85-K-0643; DA Proj. RR0-4204; DA Proj. RR0-4206)
(AD-A181493; TR-3) Avail: NTIS MF A01 CSCL 05H

This report continues our series on the short-term dynamics of human visual memory. We summarize the history of the problem, discuss some properties that define a representation as being visual, outline a new approach embodied in four experimental procedures, consider some general issues of design and analysis in assessing an array-size effect, and report on findings from a set of experiments using the spatial-probe procedure with a visual marker as probe. The principal phenomenon is an effect of array size (3 to 6 digit elements) on the time to name a visually marked element in a brief visual display that increases rapidly with marker delay, revealing a transformation of the internal representation of the array that is completed within a second. For early markers the effect of array size is negligible, indicating a property of direct access by spatial location. For late markers the effect of array size on mean reaction time is a linear increase. GRA

**N87-27397*#** Texas Univ., Austin. Dept. of Psychology.
**THE CRITICAL ROLE OF PERSONALITY AND ORGANIZATIONAL FACTORS AS DETERMINANTS OF REACTIONS TO RESTRICTED AND STRESSFUL ENVIRONMENTS**
Robert L. Helmreich 1987 16 p Presented at the 3rd International Conference on Rest, New York, N.Y., 28 Aug. 1987 Sponsored in cooperation with ONR
(Contract NCC2-286)
(NASA-CR-180621; NAS 1.26:180621) Avail: NTIS HC A02/MF A01 CSCL 05I

Research into the impact of personality factors on groups in various settings is reviewed as an introduction to a brief discussion of personality and group behavior research needs relevant to the space program. Significant findings of some earlier research are summarized, and methodological problems are touched on. The study of intergroup and intragroup conflict in a stressful environment, as exemplified particularly by undersea habitats, is seen as being of consequence for long-term space missions. It is concluded that adequate research can only be conducted as an adjunct to data collection from operational stressful environments, and not from laboratory experiments. J.P.B.

**N87-27398*#** Texas Univ., Austin. Dept. of Psychology.
**HUMAN PERFORMANCE IN AEROSPACE ENVIRONMENTS: THE SEARCH FOR PSYCHOLOGICAL DETERMINANTS**
Robert L. Helmreich and John A. Wilhelm 1987 35 p
(Contract NCC2-286)
(NASA-CR-180326; NAS 1.26:180326) Avail: NTIS HC A03/MF A01 CSCL 05I

A program of research into the psychological determinants of individual and crew performance in aerospace environments is described. Constellations of personality factors influencing behavior in demanding environments are discussed. Relationships between attitudes and performance and attitudes and personality are also reported. The efficacy of training in interpersonal relations as a means of changing attitudes and behavior is explored along with the influence of personality on attitude change processes. Finally, approaches to measuring group behavior in aerospace settings are described. Author

**N87-27399*#** Texas Univ., Austin. Dept. of Psychology.
**MAKING IT WITHOUT LOSING IT: TYPE A, ACHIEVEMENT MOTIVATION, AND SCIENTIFIC ATTAINMENT REVISITED**
Robert L. Helmreich, Janet T. Spence, and Robert S. Pred [1987] 25 p
(Contract NCC2-286)
(NASA-CR-180321; NAS 1.26:180321) Avail: NTIS HC A02/MF A01 CSCL 05I

In a study by Matthews et al. (1980), responses by academic psychologists to the Jenkins Activity Survey for Health Prediction, a measure of the Type A construct, were found to be significantly, positively correlated with two measures of attainment, citations by others to published work and number of publications. In the present study, JAS responses from the Matthews et al. sample were subjected to a factor analysis with oblique rotation and two new subscales were developed on the basis of this analysis. The first, Achievement Strivings (AS) was found to be significantly correlated with both the publication and citation measures. The second scale, Impatience and Irritability (I/I), was uncorrelated with the achievement criteria. Data from other samples indicate that I/I is related to a number of health symptoms. The results suggest that the current formulation of the Type A construct may contain two components, one associated with positive achievement and the other with poor health. Author

**N87-27400*#** Texas Univ., Austin. Dept. of Psychology.
**IMPATIENCE VERSUS ACHIEVEMENT STRIVINGS IN THE TYPE A PATTERN: DIFFERENTIAL EFFECTS ON STUDENTS' HEALTH AND ACADEMIC ACHIEVEMENT**
Janet T. Spence, Robert L. Helmreich, and Robert S. Pred 1987 44 p
(Grant NAG2-137)
(NASA-CR-180693; NAS 1.26:180693) Avail: NTIS HC A03/MF A01 CSCL 05I

Psychometric analyses of college students' responses to the Jenkins Activity Survey, a self-report measure of the Type A behavior pattern, revealed the presence of two relatively independent factors. Based on these analyses, two scales, labeled Achievement Strivings (AS) and Impatience and Irritability (II), were developed. In two samples of male and female college students, scores on AS but not on II were found to be significantly correlated with grade point average. Responses to a health survey, on the other hand, indicated that frequency of physical complaints was significantly correlated with II but not with AS. These results suggest that there are two relatively independent factors in the Type A pattern that have differential effects on performance and health. Future research on the personality factors related to coronary heart disease and other disorders might more profitably focus on the syndrome reflected in the II scale than on the Type A pattern. Author

**N87-27401#** Admiralty Research Establishment, Teddington (England).
**AUTOMATICITY AND THE CAPTURE OF ATTENTION BY A PERIPHERAL DISPLAY CHANGE**
N. K. Mohindra, E. Spencer, and A. Lambert Dec. 1986 16 p
(ARE-TM(AXB)86503; BR101672; ETN-87-90091) Copyright Avail: NTIS HC A02/MF A01

The proposal that peripheral visual changes (cues) tend to summon attention automatically was tested by studying the effect of peripheral cueing on simple detection latency. Delay between cue onset and target onset, the contingent relationship between cue location and target location, and instructions to subjects were manipulated. Results show that a peripheral display change captures attention even when the target is far more likely to appear at an uncued location. When subjects were explicitly informed that targets were likely to appear away from the cued location they can suppress this effect, but are unable to completely reverse it by rapidly orienting attention towards the uncued side. Hence the process appears to be automatic in the sense that it occurs unless there are explicit instructions to the contrary. With explicit instructions the processing operation can be suppressed, but not completely reversed. ESA

# 54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

Includes human engineering; biotechnology; and space suits and protective clothing.

For related information see also *16 Space Transportation.*

**N87-27402#** Human Machine Interfaces, Inc., Knoxville, Tenn.
**THE IMPLICATIONS OF FORCE REFLECTION FOR TELEOPERATION IN SPACE**
J. V. Draper, J. N. Herndon, and W. E. Moore 1987 24 p Presented at the Goddard Conference on Space Applications of Artificial Intelligence and Robotics, Greenbelt, Md., 14 May 1987 Prepared in cooperation with Oak Ridge National Lab., Tenn.
(Contract DE-AC05-84OR-21400)
(DE87-008585; CONF-870591-1) Avail: NTIS HC A02/MF A01

Previous research on teleoperator force feedback is reviewed and results of a testing program which assessed the impact of force reflection on teleoperator task performance are reported. Force reflection is a type of force feedback in which the forces acting on the remote portion of the teleoperator are displayed to the operator by back-driving the master controller. The testing program compared three force reflection levels: 4 to 1 (four units of force on the slave produce one unit of force at the master controller), 1 to 1, and infinity to 1 (no force reflection). Time required to complete tasks, rate of occurrence of errors, the maximum force applied to tasks components, and variability in forces applied to components during completion of representative remote handling tasks were used as dependent variables. Operators exhibited lower error rates, lower peak forces, and more consistent application of forces using force reflection than they did without it. These data support the hypothesis that force reflection provides useful information for teleoperator users. The earlier literature and the results of the experiment are discussed in terms of their implications for space based teleoperator systems. The discussion describes the impact of force reflection on task completion performance and task strategies, as suggested by the literature. It is important to understand the trade-offs involved in using telerobotic systems with and without force reflection. DOE

**N87-27403#** Florida Inst. of Tech., Melbourne.
**HUMAN PERFORMANCE TASK BATTERIES AND MODELS: AN ABILITIES-BASED DIRECTORY Final Report, 6 Sep. 1985 - 30 Nov. 1986**
Daniel J. Pond, Deborah L. DesRochers, and James E. Driskell 1 Dec. 1986 96 p
(Contract DAAG29-81-D-0100)
(AD-A180751; NTSC-TR-86-020) Avail: NTIS HC A05/MF A01 CSCL 05H

This Directory represents the start of a research program directed towards the creation of a human abilities matrix which cross-references data on real world jobs, laboratory performance tasks, and human performance models. The matrix will use the abilities requirements approach of Fleishman & Quaintance (1984) as the unifying element among these three dimensions. The present effort compiles and cross-references information on computer-based performance assessment batteries and models/theories of human performance. Data from ten batteries, one hundred twenty-three tasks, and seven models have been included. For the performance batteries, this information includes availability/acquisition details as well as computer hardware and software characteristics. This document, then, enables researchers to quickly access such data as well as to ascertain those areas in which a paucity of data exists. GRA

**N87-27404#** Naval Postgraduate School, Monterey, Calif.
**EXPERIMENTAL STUDIES OF JOINT FLEXIBILITY FOR PUMA 560 ROBOT M.S. Thesis**
Dennis K. Gonyier Mar. 1987 63 p
(AD-A181451) Avail: NTIS HC A04/MF A01 CSCL 13I

There is a potential in the Navy and the Department of Defense for the utilization of robot manipulators in a wide range of applications. First, they could be used in applications that are performed in environments dangerous to men. These include underwater work, fire fighting, tank and void preservation and reactor spaces. Second, many patrol and/or security functions could be performed by robot releasing the operator to a position of supervisory control over many units. Third, robotic submersibles are being used now to explore areas of our undersea environment that were out of economical range before their use. This will lead to a closer determination of the resources available in our oceans and their subsequent exploitation. There is also a large potential for the use of robots in space. The weight limitations will demand manipulators to be flexible compared to the industrial machines currently available. The problems of control of these flexible arms will have to be studied prior to their implementation. In addition, the robot manipulators currently installed in industry have the potential for increased productivity if their performance could be enhanced. This latter requires an understanding of the flexibility effects and their integration into the control algorithm. GRA

**N87-27405*#** Texas Univ., Austin. Dept. of Psychology.
**THE UNDERSEA HABITAT AS A SPACE STATION ANALOG: EVALUATION OF RESEARCH AND TRAINING POTENTIAL**
Robert L. Helmreich and John A. Wilhelm 1 Oct. 1985 20 p
(Contract NCC2-286)
(NASA-CR-180342; NAS 1.26:180342) Avail: NTIS HC A02/MF A01 CSCL 05H

An evaluation is given of the utility of undersea habitats for both research and training on behavioral issues relative to the space station. The feasibility of a particular habitat, La Chalupa, is discussed. Author

**N87-27406*#** Texas Univ., Austin. Dept. of Psychology.
**LIVING IN CONTAINED ENVIRONMENTS: RESEARCH IMPLICATIONS FROM UNDERSEA HABITATS**
Robert L. Helmreich 1986 15 p Presented at Individuals and Group Behavior in Toxic and Contained Environments: A Conference to Explore the Psychological Effects of Chemical and Biological Warfare, Austin, Tex., 13 Dec. 1986
(Contract NCC2-286)
(NASA-CR-180341; NAS 1.26:180341) Avail: NTIS HC A02/MF A01 CSCL 05H

A cost-reward model is used to frame a discussion of differences in observed behavior of individuals and groups in confined environments. It has been observed that the high cost of functioning in a stressful environment is likely to produce poor performance when anticipated rewards are low but that participants can manage the stress and achieve high performance if they anticipate high rewards. The high-reward environment is exemplified by early undersea habitats such as Sealab and Tektite and by early space missions. Other aspects of behavior occur in all confined environments and point to an important area for future research. Of particular interest are intergroup conflicts arising between the confined group and its external control. Also, individual differences in personality seem always to have an impact in confined environments. Recent research has focused on: (1) predicting performance and adjustment based on instrumental and expressive aspects of the self; (2) the differential predictive power of achievement striving and irritation/irritability in Type A personalities; and (3) the nature and role of leadership in small, isolated groups. J.P.B.

**N87-27407*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
**SPACE SUIT EXTRAVEHICULAR HAZARDS PROTECTION DEVELOPMENT**
Joseph J. Kosmo 14 Jan. 1987 32 p
(NASA-TM-89355; NAS 1.15:89355) Avail: NTIS HC A03/MF A01 CSCL 06K

Presented is an overview of the development of the integral thermal/micrometeoroid garment (ITMG) used for protection of a space-suited crewmember from hazards of various extravehicular environments. These hazard conditions can range from thermal extremes, meteoroid and debris particles, and radiation conditions

in near-earth orbits and free space to sand and dust environments encountered on lunar or planetary surfaces. Representative ITMG materials cross-section layups are identified and described for various space-suit configurations ranging from the Gemini Program to planned protective requirements and considerations for anticipated Space Station EV operations. Author

**N87-27408#** Oak Ridge National Lab., Tenn.
**REMOTE HANDLING FACILITY AND EQUIPMENT USED FOR SPACE TRUSS ASSEMBLY**
T. W. Burgess 1987 8 p Presented at the Goddard Conference on Space Applications of Artificial Intelligence and Robotics, Greenbelt, Md., 14 May 1987
(Contract DE-AC05-84OR-21400)
(DE87-009121; CONF-870591-3) Avail: NTIS HC A02/MF A01

The ACCESS truss remote handling experiments were performed at Oak Ridge National Laboratory's (ORNL's) Remote Operation and Maintenance Demonstration (ROMD) facility. The ROMD facility has been developed by the US Department of Energy's (DOE's) Consolidated Fuel Reprocessing Program to develop and demonstrate remote maintenance techniques for advanced nuclear fuel reprocessing equipment and other programs of national interest. The facility is a large-volume, high-bay area that encloses a complete, technologically advanced remote maintenance system that first began operation in FY 1982. The maintenance system consists of a full complement of teleoperated manipulators, manipulator transport systems, and overhead hoists that provide the capability of performing a large variety of remote handling tasks. ACCESS truss remote assembly was performed in the ROMD facility using the Central Research Laboratory's (CRL) model M-2 servomanipulator. The model M-2 is a dual-arm, bilateral force-reflecting, master/slave servomanipulator which was jointly developed by CRL and ORNL and represents the state of the art in teleoperated manipulators commercially available in the United States today. The model M-2 servomanipulator incorporates a distributed, microprocessor-based digital control system and was the first successful implementation of an entirely digitally controlled servomanipulator. The system has been in operation since FY 1983. DOE

**N87-27409*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**A NEW ILLUSION OF PROJECTED THREE-DIMENSIONAL SPACE**
Stephen R. Ellis and Arthur Grunwald Jul. 1987 11 p
(NASA-TM-100006; A-87285; NAS 1.15:100006) Avail: NTIS HC A02/MF A01 CSCL 05H

When perspective projections of orbital trajectories plotted in local-vertical local-horizontal coordinates are viewed with certain viewing angles, their appearance becomes perceptually unstable. They often lose their trochoidal appearance and reorganize as helices. This reorganization may be due to the viewer's familiarity with coiled springs. Author

# 55 SPACE BIOLOGY

Includes exobiology; planetary biology; and extraterrestrial life.

**N87-27410*#** National Aeronautics and Space Administration, Washington, D.C.
**EXTRATERRESTRIAL CIVILIZATIONS: PROBLEMS OF THEIR EVOLUTION**
L. V. Leskov Aug. 1987 48 p Transl. into ENGLISH from Novoye v Zhizni, Nauke, Tekhnike, Seriya: Kosmonavtika, Astronomiya (USSR), no. 8, 1985 p 1-55 Transl. by The Corporate Word, Inc., Pittsburgh, Pa.
(Contract NASw-4006)
(NASA-TT-20060; NAS 1.77:20060) Avail: NTIS HC A03/MF A01 CSCL 06C

The problem of finding extraterrestrial civilizations and establishing contact with them is directly related to the problem of their evolution. Possible patterns in this evolution and the stages in the evolution of extraterrestrial civilizations are examined. Author

# 59 MATHEMATICAL AND COMPUTER SCIENCES (GENERAL)

No abstracts in this category.

# 60 COMPUTER OPERATIONS AND HARDWARE

Includes hardware for computer graphics, firmware, and data processing.

For components see *33 Electronics and Electrical Engineering.*

**N87-27411*#** Illinois Univ., Urbana. Coordinated Science Lab.
**ANALYSIS OF MEMORY USE FOR IMPROVED DESIGN AND COMPILE-TIME ALLOCATION OF LOCAL MEMORY**
Geoffrey D. McNiven and Edward S. Davidson 29 Jan. 1986 27 p
(Grant NAG1-163)
(NASA-CR-180377; NAS 1.26:180377) Avail: NTIS HC A03/MF A01 CSCL 09B

Trace analysis techniques are used to study memory referencing behavior for the purpose of designing local memories and determining how to allocate them for data and instructions. In an attempt to assess the inherent behavior of the source code, the trace analysis system described here reduced the effects of the compiler and host architecture on the trace by using a technical called flattening. The variables in the trace, their associated single-assignment values, and references are histogrammed on the basis of various parameters describing memory referencing behavior. Bounds are developed specifying the amount of memory space required to store all live values in a particular histogram class. The reduction achieved in main memory traffic by allocating local memory is specified for each class. Author

# 61 COMPUTER PROGRAMMING AND SOFTWARE

Includes computer programs, routines, alogorithms, and specific applications, e.g., CAD/CAM.

**N87-27412*#** Illinois Univ., Urbana. Dept. of Computer Science.
**SAGA: A PROJECT TO AUTOMATE THE MANAGEMENT OF SOFTWARE PRODUCTION SYSTEMS Mid-Year Report, 1986**
Roy H. Campbell, C. S. Beckman-Davies, L. Benzinger, G. Beshers, D. Laliberte, H. Render, R. Sum, W. Smith, and R. Terwilliger 21 Oct. 1986 607 p
(Grant NAG1-138)
(NASA-CR-180276; NAS 1.26:180276) Avail: NTIS HC A99/MF A01 CSCL 09B

Research into software development is required to reduce its production cost and to improve its quality. Modern software systems, such as the embedded software required for NASA's space station initiative, stretch current software engineering techniques. The requirements to build large, reliable, and maintainable software systems increases with time. Much theoretical and practical research is in progress to improve software engineering techniques. One such technique is to build a software

system or environment which directly supports the software engineering process, i.e., the SAGA project, comprising the research necessary to design and build a software development which automates the software engineering process. Progress under SAGA is described. Author

**N87-27413*#** George Washington Univ., Washington, D.C. Inst. for Information Science and Technology.
**ICL: THE IMAGE COMPOSITION LANGUAGE**
James D. Foley and Won Chul Kim Sep. 1986 37 p
(Grant NAG1-538)
(NASA-CR-180313; NAS 1.26:180313; GWU-IIST-86-26) Avail: NTIS HC A03/MF A01 CSCL 09B

The Image Composition Language (ICL) provides a convenient way for programmers of interactive graphics application programs to define how the video look-up table of a raster display system is to be loaded. The ICL allows one or several images stored in the frame buffer to be combined in a variety of ways. The ICL treats these images as variables, and provides arithematic, relational, and conditional operators to combine the images, scalar variables, and constants in image composition expressions. The objective of ICL is to provide programmers with a simple way to compose images, to relieve the tedium usually associated with loading the video look-up table to obtain desired results. Author

**N87-27414*#** Maryland Univ., College Park. Systems Research Center.
**OPTIMAL BLOCK COSINE TRANSFORM IMAGE CODING FOR NOISY CHANNELS**
V. Vaishampayan and N. Farvardin 25 Aug. 1986 29 p
(Grants NAG1-582; NSF CDR-85-00108)
(NASA-CR-180309; NAS 1.26:180309; TR-86-37) Avail: NTIS HC A03/MF A01 CSCL 09B

The two dimensional block transform coding scheme based on the discrete cosine transform was studied extensively for image coding applications. While this scheme has proven to be efficient in the absence of channel errors, its performance degrades rapidly over noisy channels. A method is presented for the joint source channel coding optimization of a scheme based on the 2-D block cosine transform when the output of the encoder is to be transmitted via a memoryless design of the quantizers used for encoding the transform coefficients. This algorithm produces a set of locally optimum quantizers and the corresponding binary code assignment for the assumed transform coefficient statistics. To determine the optimum bit assignment among the transform coefficients, an algorithm was used based on the steepest descent method, which under certain convexity conditions on the performance of the channel optimized quantizers, yields the optimal bit allocation. Comprehensive simulation results for the performance of this locally optimum system over noisy channels were obtained and appropriate comparisons against a reference system designed for no channel error were rendered. Author

**N87-27415*#** Old Dominion Univ., Norfolk, Va. Dept. of Computer Science.
**USER INTERFACE FOR INTEGRATED COMPUTER AIDED DESIGN SYSTEMS Final Report, 1 Jan. 1983 - 31 May 1985**
James L. Schwing Nov. 1986 143 p
(Contract NCC1-74)
(NASA-CR-180328; NAS 1.26:180328) Avail: NTIS HC A07/MF A01 CSCL 09B

The purpose was the development of a user interface and other appropriate tools to be used in Computer Aided Design systems which can integrate a wide variety of independently developed design and analysis tools. The interface was intended for the integration of programs to be used in the conceptual design of aerospace systems. A user's manual is included. Author

**N87-27416*#** Old Dominion Univ., Norfolk, Va. Dept. of Physics.
**SUPPORT OF VALIDATION OF SAGE 2 DATA Final Report, period ending 31 Dec. 1986**
Gary E. Copeland Nov. 1986 47 p
(Contract NCC1-96)
(NASA-CR-180325; NAS 1.26:180325; PTR-86-6) Avail: NTIS HC A03/MF A01 CSCL 09B

An error analysis of differential absorption lidar (DIAL) measurements of stratospheric ozone from a Space Shuttle is discussed. A transmitter system consisting of a KrF excimer laser pumping gas cells of H2 or D2 producing output wavelengths in the near UV is shown to be useful for the measurement of ozone in an altitude range from 15 to 50 km. Author

**N87-27417*#** George Washington Univ., Hampton, Va.
**INVESTIGATION OF SCENE IDENTIFICATION ALGORITHMS FOR RADIATION BUDGET MEASUREMENTS Final Report**
F. J. Diekmann Dec. 1986 59 p Prepared in cooperation with Joint Inst. for Advancement of Flight Sciences, Hampton, Va.
(Grant NsG-1555)
(NASA-CR-180324; NAS 1.26:180324) Avail: NTIS HC A04/MF A01 CSCL 09B

The computation of Earth radiation budget from satellite measurements requires the identification of the scene in order to select spectral factors and bidirectional models. A scene identification procedure is developed for AVHRR SW and LW data by using two radiative transfer models. These AVHRR GAC pixels are then attached to corresponding ERBE pixels and the results are sorted into scene identification probability matrices. These scene intercomparisons show that there generally is a higher tendency for underestimation of cloudiness over ocean at high cloud amounts, e.g., mostly cloudy instead of overcast, partly cloudy instead of mostly cloudy, for the ERBE relative to the AVHRR results. Reasons for this are explained. Preliminary estimates of the errors of exitances due to scene misidentification demonstrates the high dependency on the probability matrices. While the longwave error can generally be neglected the shortwave deviations have reached maximum values of more than 12% of the respective exitances. Author

**N87-27418*#** Virginia Univ., Charlottesville. Dept. of Computer Science.
**THE IMPLEMENTATION AND USE OF ADA ON DISTRIBUTED SYSTEMS WITH HIGH RELIABILITY REQUIREMENTS Semiannual Report, 5 Mar. 1982 - 31 Dec. 1986**
J. C. Knight Mar. 1987 104 p
(Grant NAG1-260)
(NASA-CR-180670; NAS 1.26:180670; UVA/528213/CS87/110)
Avail: NTIS HC A06/MF A01 CSCL 09B

A preliminary analysis of the Ada implementation of the Advanced Transport Operating System (ATOPS), an experimental computer control system developed at NASA Langley for a modified Boeing 737 aircraft, is presented. The criteria that was determined for the evaluation of this approach is described. A preliminary version of the requirements for the ATOPS is contained. This requirements specification is not a formal document, but rather a description of certain aspects of the ATOPS system at a level of detail that best suits the needs of the research. The survey of backward error recovery techniques is also presented. B.G.

**N87-27419*#** Virginia Univ., Charlottesville. Dept. of Computer Science.
**SECOND GENERATION EXPERIMENTS IN FAULT TOLERANT SOFTWARE Annual Progress Report, 1 Sep. 1984 - 31 Jan. 1988**
J. C. Knight Mar. 1987 93 p
(Grant NAG1-511)
(NASA-CR-180675; NAS 1.26:180675; UVA/528235/CS87/104)
Avail: NTIS HC A05/MF A01 CSCL 09B

The purpose of the Multi-Version Software (MVS) experiment is to obtain empirical measurements of the performance of multi-version systems. Twenty version of a program were prepared under reasonably realistic development conditions from the same specifications. The overall structure of the testing environment for the MVS experiment and its status are described. A preliminary version of the control system is described that was implemented for the MVS experiment to allow the experimenter to have control

over the details of the testing. The results of an empirical study of error detection using self checks are also presented. The analysis of the checks revealed that there are great differences in the ability of individual programmers to design effective checks. B.G.

**N87-27420*#** Illinois Univ., Urbana. Coordinated Science Lab.
**A PARALLEL SIMULATED ANNEALING ALGORITHM FOR STANDARD CELL PLACEMENT ON A HYPERCUBE COMPUTER**
Mark Howard Jones Jan. 1987 86 p
(Grant NAG1-613)
(NASA-CR-180676; NAS 1.26:180676; UILU-ENG-87-2209; CSG-60) Avail: NTIS HC A05/MF A01 CSCL 09B

A parallel version of a simulated annealing algorithm is presented which is targeted to run on a hypercube computer. A strategy for mapping the cells in a two dimensional area of a chip onto processors in an n-dimensional hypercube is proposed such that both small and large distance moves can be applied. Two types of moves are allowed: cell exchanges and cell displacements. The computation of the cost function in parallel among all the processors in the hypercube is described along with a distributed data structure that needs to be stored in the hypercube to support parallel cost evaluation. A novel tree broadcasting strategy is used extensively in the algorithm for updating cell locations in the parallel environment. Studies on the performance of the algorithm on example industrial circuits show that it is faster and gives better final placement results than the uniprocessor simulated annealing algorithms. An improved uniprocessor algorithm is proposed which is based on the improved results obtained from parallelization of the simulated annealing algorithm. Author

**N87-27421*#** Illinois Univ., Urbana-Champaign. Coordinated Science Lab.
**RECONFIGURABLE TREE ARCHITECTURES USING SUBTREE ORIENTED FAULT TOLERANCE**
Matthew B. Lowrie Mar. 1987 48 p
(Grant NAG1-613)
(NASA-CR-180677; NAS 1.26:180677; UILU-ENG-87-2216; CSG-65) Avail: NTIS HC A03/MF A01 CSCL 09B

An approach to the design of reconfigurable tree architecture is presented in which spare processors are allocated at the leaves. The approach is unique in that spares are associated with subtrees and sharing of spares between these subtrees can occur. The Subtree Oriented Fault Tolerance (SOFT) approach is more reliable than previous approaches capable of tolerating link and switch failures for both single chip and multichip tree implementations while reducing redundancy in terms of both spare processors and links. VLSI layout is 0(n) for binary trees and is directly extensible to N-ary trees and fault tolerance through performance degradation. Author

**N87-27422*#** College of William and Mary, Williamsburg, Va.
**DATA INVERSION ALGORITHM DEVELOPMENT FOR THE HOLOGEN OCCULTATION EXPERIMENT Final Report, 1 Dec. 1984 - 1 Nov. 1985**
Larry L. Gordley and Martin G. Mlynczak [1986] 78 p
(Contract NCC1-91)
(NASA-CR-180685; NAS 1.26:180685) Avail: NTIS HC A05/MF A01 CSCL 09B

The successful retrieval of atmospheric parameters from radiometric measurement requires not only the ability to do ideal radiometric calculations, but also a detailed understanding of instrument characteristics. Therefore a considerable amount of time was spent in instrument characterization in the form of test data analysis and mathematical formulation. Analyses of solar-to-reference interference (electrical cross-talk), detector nonuniformty, instrument balance error, electronic filter time-constants and noise character were conducted. A second area of effort was the development of techniques for the ideal radiometric calculations required for the Halogen Occultation Experiment (HALOE) data reduction. The computer code for these calculations must be extremely complex and fast. A scheme for meeting these requirements was defined and the algorithms needed form implementation are currently under development. A third area of work included consulting on the implementation of the Emissivity Growth Approximation (EGA) method of absorption calculation into a HALOE broadband radiometer channel retrieval algorithm. B.G.

**N87-27423*#** Old Dominion Univ., Norfolk, Va. Dept. of Computer Science.
**GEOMETRIC MODELING FOR COMPUTER-AIDED DESIGN Progress Report, period ending 31 Dec. 1986**
James L. Schwing and Jan Spangler Mar. 1987 42 p
(Contract NCC1-99)
(NASA-CR-180686; NAS 1.26:180686) Avail: NTIS HC A03/MF A01 CSCL 09B

Software was developed to be used with the derivation of smooth three dimensional surfaces from a sequence of cross sections. Problems arising in the creation of surfaces by extrusion are considered and calculated physical properties are presented. Author

**N87-27424*#** Columbia Univ., New York.
**GRID GENERATION ON SURFACES IN 3 DIMENSIONS Final Scientific Report, 1 Oct. 1985 - 30 Sep. 1986**
Peter R. Eiseman Sep. 1986 9 p Sponsored in part by NAVSEA
(Grant NAG1-617)
(NASA-CR-180559; NAS 1.26:180559) Avail: NTIS HC A02/MF A01 CSCL 09B

The development of a surface grid generation algorithm was initiated. The basic adaptive movement technique of mean-value-relaxation was extended from the viewpoint of a single coordinate grid over a surface described by a single scalar function to that of a surface more generally defined by vector functions and covered by a collection of smoothly connected grids. Within the multiconnected assemblage, the application of control was examined in several instances. Author

**N87-27425*#** Colorado Univ., Boulder.
**PARALLEL SOFTWARE SUPPORT FOR COMPUTATIONAL STRUCTURAL MECHANICS Semiannual Report, 1 Dec. 1986 - 31 May 1987**
Harry F. Jordan 1987 4 p
(Grant NAG1-640)
(NASA-CR-180963; NAS 1.26:180963) Avail: NTIS HC A02/MF A01 CSCL 09B

The application of the parallel programming methodology known as the Force was conducted. Two application issues were addressed. The first involves the efficiency of the implementation and its completeness in terms of satisfying the needs of other researchers implementing parallel algorithms. Support for, and interaction with, other Computational Structural Mechanics (CSM) researchers using the Force was the main issue, but some independent investigation of the Barrier construct, which is extremely important to overall performance, was also undertaken. Another efficiency issue which was addressed was that of relaxing the strong synchronization condition imposed on the self-scheduled parallel DO loop. The Force was extended by the addition of logical conditions to the cases of a parallel case construct and by the inclusion of a self-scheduled version of this construct. The second issue involved applying the Force to the parallelization of finite element codes such as those found in the NICE/SPAR testbed system. One of the more difficult problems encountered is the determination of what information in COMMON blocks is actually used outside of a subroutine and when a subroutine uses a COMMON block merely as scratch storage for internal temporary results. B.G.

**N87-27426*#** Brigham Young Univ., Provo, Utah. Engineering Computer Graphics Lab.
**RASTER GRAPHICS DISPLAY LIBRARY Final Report**
Anders Grimsrud and Michael B. Stephenson 30 Jun. 1987 277 p
(Grant NAG1-391)

(NASA-CR-181025; NAS 1.26:181025; ECGL-87-03) Avail: NTIS HC A13/MF A01 CSCL 09B

The Raster Graphics Display Library (RGDL) is a high level subroutine package that give the advanced raster graphics display capabilities needed. The RGDL uses FORTRAN source code routines to build subroutines modular enough to use as stand-alone routines in a black box type of environment. Six examples are presented which will teach the use of RGDL in the fastest, most complete way possible. Routines within the display library that are used to produce raster graphics are presented in alphabetical order, each on a separate page. Each user-callable routine is described by function and calling parameters. All common blocks that are used in the display library are listed and the use of each variable within each common block is discussed. A reference on the include files that are necessary to compile the display library is contained. Each include file and its purpose are listed. The link map for MOVIE.BYU version 6, a general purpose computer graphics display system that uses RGDL software, is also contained. B.G.

**N87-27427#** National Bureau of Standards, Gaithersburg, Md. Statistical Engineering Div.

**DATAPLOT: IMPLEMENTATION MANUAL, VERSION 87.1**

J. J. Filliben Jan. 1987 83 p Previously announced as N85-12610

(PB87-161014; NBS/SW/MT-87/005B) Avail: NTIS HC A05/MF A01 CSCL 09B

DATAPLOT is a portable, high-level interactive language/system for graphics, fitting, data analysis, and mathematics. It has wide applicability (especially in a research/scientific/engineering environment). The manual outlines the step-by-step procedure for implementing DATAPLOT 87.1. Inasmuch as the underlying DATAPLOT code is portable (FORTRAN 77), and inasmuch as transportability considerations are an integral part of the design, then this described implementation procedure is valid and appropriate for a wide variety of mainframes and minis. GRA

**N87-27428#** National Bureau of Standards, Gaithersburg, Md. Statistical Engineering Div.

**DATAPLOT: NEW FEATURES, VERSION 87.1**

J. J. Filliben Jan. 1987 62 p Previously announced as N85-10708

(PB87-161006; NBS/SW/MT-87/005A) Avail: NTIS HC A04/MF A01 CSCL 09B

An overview of the new features which were implemented into DATAPLOT from July 1985 to December 1986 are presented. These features enhance not only the analysis power of DATAPLOT, but also the ease-of-use of DATAPLOT. All enhancements featured were incorporated into the DATAPLOT 87.1 release. GRA

**N87-27429*#** Atlanta Univ., Ga. Dept. of Mathematical and Computer Sciences.

**FUZZY AUTOMATA AND PATTERN MATCHING Final Report, 1 Oct. 1983 - 30 Sep. 1986**

C. B. Setzer and N. A. Warsi 1986 119 p

(Grant NAG1-412)

(NASA-CR-181166; NAS 1.26:181166) Avail: NTIS HC A06/MF A01 CSCL 09B

A wide-ranging search for articles and books concerned with fuzzy automata and syntactic pattern recognition is presented. A number of survey articles on image processing and feature detection were included. Hough's algorithm is presented to illustrate the way in which knowledge about an image can be used to interpret the details of the image. It was found that in hand generated pictures, the algorithm worked well on following the straight lines, but had great difficulty turning corners. An algorithm was developed which produces a minimal finite automaton recognizing a given finite set of strings. One difficulty of the construction is that, in some cases, this minimal automaton is not unique for a given set of strings and a given maximum length. This algorithm compares favorably with other inference algorithms. More importantly, the algorithm produces an automaton with a rigorously described relationship to the original set of strings that does not depend on the algorithm itself. B.G.

**N87-27430#** Massachusetts Inst. of Tech., Lexington. Lincoln Lab.

**SILHOUETTE-SLICE THEOREMS Ph.D. Thesis**

Patrick L. VanHove 20 Mar. 1987 235 p

(Contract F19628-85-C-0002; ARPA Order 3797)

(AD-A180955; TR-764; ESD-TR-86-046) Avail: NTIS HC A11/MF A01 CSCL 12B

In this report, a new theory analyzing the relations between 3-D convex objects and their silhouettes in orthographic projections is presented. The theory is based on three new representations of 3-D surfaces in terms of scalar, vector and tensor functions on the Gaussian sphere, and the matching representation of 2-D curves by functions on the Gaussian circle. The key advantage of these representations is that a slice through the spherical representation of a 3-D object is closely related to the circular representation of the silhouette of the object in a plane parallel to the slice. This relation is formalized in three Silhouette-Slice theorems, which underline the duality between silhouettes in object space and slices in the representation space. These theorems apply to opaque objects and have a conceptual similarity with the Projection-Slice theorem, which applies to absorbing objects. Silhouette construction with the theorems is demonstrated by examples of silhouettes of complex curved surfaces. Applications to the reconstruction of object shapes from silhouette measurements and to the recognition of objects based on their silhouettes are suggested. Author (GRA)

**N87-27431#** YLYK Ltd., Ann Arbor, Mich.

**REDUCTION OF FLOW DIAGRAMS TO UNFOLDED FORM MODULO SNARLS Final Report, 15 Sep. 1986 - 14 Feb. 1987**

George R. Blakley, III 14 Apr. 1987 91 p

(Contract F49620-86-C-0103)

(AD-A181390; AFOSR-87-0789TR) Avail: NTIS HC A05/MF A01 CSCL 09B

This research effort produced five low-degree polynomial time algorithms for turning a complete but merely local description of a flow diagram (or graph). The most remarkable feature of these five algorithms is that all of them overcome the problem of scale. This means that the representations they produce have the property that the operation boxes on flow paths (or vertices and edges) are drawn with a uniform spacing which exhibits neither crowding nor excessive white space. Every output of every one of them is very readable. The most important of them produces a plane, straight-line drawing, without crossovers, of any planar graph. The drawing can be performed in a natural and uncrowded manner on a 3v by 2v piece of graph paper, where v is the number of vertices in the graph. The research relates these graph-representation problems to fundamental problems in structured programming, especially the role of GOTOs and the uses of new non-imperative paradigms. GRA

**N87-27432*#** Virginia Univ., Charlottesville. Dept. of Computer Science.

**THE IMPLEMENTATION AND USE OF Ada ON DISTRIBUTED SYSTEMS WITH HIGH RELIABILITY REQUIREMENTS Semiannual Progress Report, 5 Mar. 1982 - 14 Feb. 1988**

J. C. Knight Aug. 1987 42 p

(Grant NAG1-260)

(NASA-CR-180339; NAS 1.26:180339; UVA/528213/CS88/111) Avail: NTIS HC A03/MF A01 CSCL 09B

Performance analysis was begin on the Ada implementations. The goal is to supply the system designer with tools that will allow a rational decision to be made about whether a particular implementation can support a given application early in the design cycle. Primary activities were: analysis of the original approach to recovery in distributed Ada programs using the Advanced Transport Operating System (ATOPS) example; review and assessment of the original approach which was found to be capable of improvement; preparation and presentation of a paper at the 1987 Washington DC Ada Symposium; development of a refined approach to recovery that is presently being applied to the ATOPS example; and design and development of a performance

assessment scheme for Ada programs based on a flexible user-driven benchmarking system. B.G.

**N87-27433*#** Virginia Univ., Charlottesville. Dept. of Computer Science.
**DETECTION OF FAULTS AND SOFTWARE RELIABILITY ANALYSIS Annual Progress Report, 1 Jul. 1985 - 30 Jun. 1987**
J. C. Knight Aug. 1987 14 p
(Grant NAG1-605)
(NASA-CR-180347; NAS 1.26:180347; UVA/528243/CS88/103)
Avail: NTIS HC A02/MF A01 CSCL 09B

Specific topics briefly addressed include: the consistent comparison problem in N-version system; analytic models of comparison testing; fault tolerance through data diversity; and the relationship between failures caused by automatically seeded faults. B.G.

**N87-27434*#** Johns Hopkins Univ., Baltimore, Md. Dept. of Computer Science.
**PERFORMANCE ANALYSIS OF A GENERALIZED UPSET DETECTION PROCEDURE Semiannual Progress Report**
Douglas M. Blough and Gerald M. Masson [1987] 8 p
(Grant NsG-1442)
(NASA-CR-181075; NAS 1.26:181075) Avail: NTIS HC A02/MF A01 CSCL 09B

A general procedure for upset detection in complex systems, called the data block capture and analysis upset monitoring process is described and analyzed. The process consists of repeatedly recording a fixed amount of data from a set of predetermined observation lines of the system being monitored (i.e., capturing a block of data), and then analyzing the captured block in an attempt to determine whether the system is functioning correctly. The algorithm which analyzes the data blocks can be characterized in terms of the amount of time it requires to examine a given length data block to ascertain the existence of features/conditions that have been predetermined to characterize the upset-free behavior of the system. The performance of linear, quadratic, and logarithmic data analysis algorithms is rigorously characterized in terms of three performance measures: (1) the probability of correctly detecting an upset; (2) the expected number of false alarms; and (3) the expected latency in detecting upsets. Author

**N87-27435*#** AdaSoft, Inc., Lanham, Md.
**ADA TECHNOLOGY SUPPORT FOR NASA-GSFC Final Report**
9 May 1986 14 p
(Contract NAS5-29173)
(NASA-CR-181212; NAS 1.26:181212) Avail: NTIS HC A02/MF A01 CSCL 09B

Utilization of the Ada programming language and environments to perform directorate functions was reviewed. The Mission and Data Operations Directorate Network (MNET) conversion effort was chosen as the first task for evaluation and assistance. The MNET project required the rewriting of the existing Network Control Program (NCP) in the Ada programming language. The DEC Ada compiler running on the VAX under WMS was used for the initial development efforts. Stress tests on the newly delivered version of the DEC Ada compiler were performed. The new Alsys Ada compiler was purchased for the IBM PC AT. A prevalidated version of the compiler was obtained. The compiler was then validated. B.G.

**N87-27436*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**OPTIMAL DYNAMIC REMAPPING OF PARALLEL COMPUTATIONS Final Report**
David M. Nichol and Paul F. Reynolds, Jr. (Virginia Univ., Charlottesville.) Jul. 1987 39 p Submitted for publication. Prepared in cooperation with the Collge of William and Mary, Hampton, Va.
(Contract NAS1-18107)
(NASA-CR-178344; ICASE-87-49; NAS 1.26:178344) Avail: NTIS HC A03/MF A01 CSCL 09B

A large class of computations are characterized by a sequence of phases, with phase changes occurring unpredictably. The decision problem was considered regarding the remapping of workload to processors in a parallel computation when the utility of remapping and the future behavior of the workload is uncertain, and phases exhibit stable execution requirements during a given phase, but requirements may change radically between phases. For these problems a workload assignment generated for one phase may hinder performance during the next phase. This problem is treated formally for a probabilistic model of computation with at most two phases. The fundamental problem of balancing the expected remapping performance gain against the delay cost was addressed. Stochastic dynamic programming is used to show that the remapping decision policy minimizing the expected running time of the computation has an extremely simple structure. Because the gain may not be predictable, the performance of a heuristic policy that does not require estimnation of the gain is examined. The heuristic method's feasibility is demonstrated by its use on an adaptive fluid dynamics code on a multiprocessor. The results suggest that except in extreme cases, the remapping decision problem is essentially that of dynamically determining whether gain can be achieved by remapping after a phase change. The results also suggest that this heuristic is applicable to computations with more than two phases. Author

**N87-27437#** RAND Corp., Santa Monica, Calif.
**A MICROCOMPUTER PROGRAM FOR ANALYZING MULTITRAIT-MULTIMETHOD MATRICES**
Toshi Hayashi and Ron D. Hays Jan. 1987 17 p
(P-7298) Avail: NTIS HC A02/MF A01; compiled program and documentation from RAND Corp., 1700 Main St., Santa Monica, Calif. 90406-2138

A Fortran program for IBM and IBM-compatible microcomputers is described that analyzes multitrait-multimethod (MTMM) matrices. The program minimizes the difficulty in practical applications of the MTMM technique, providing the statistical information necessary for evaluating the convergent and discriminant validity of two or more traits measured by two or more methods. Author

**N87-27438*#** Atsuko Computing International, Huntsville, Ala.
**NEW SPACE SENSOR AND MESOSCALE DATA ANALYSIS Final Report**
John S. Hickey 20 Jul. 1987 66 p
(Contract NAS8-36181)
(NASA-CR-179151; NAS 1.26:179151; ACI-072087-FR) Avail: NTIS HC A04/MF A01 CSCL 09B

The developed Earth Science and Application Division (ESAD) system/software provides the research scientist with the following capabilities: an extensive data base management capibility to convert various experiment data types into a standard format; and interactive analysis and display package (AVE80); an interactive imaging/color graphics capability utilizing the Apple III and IBM PC workstations integrated into the ESAD computer system; and local and remote smart-terminal capability which provides color video, graphics, and Laserjet output. Recommendations for updating and enhancing the performance of the ESAD computer system are listed. B.G.

**N87-27439#** MATRA Espace, Paris-Velizy (France).
**TECHNICAL ASSISTANCE FOR ONBOARD DATA HANDLING (OBDH) PROTOCOL STANDARD UPDATING Final Report**
P. Duthil Paris, France ESA 10 Sep. 1986 49 p
(Contract ESTEC-6416/85-NL-PB(SC))
(Matra-NT/139/1629; ESA-CR(P)-2354; ETN-87-90001)
Copyright Avail: NTIS HC A03/MF A01

The onboard data handling (OBDH) protocol used on European spacecraft is being extended to meet requirements of intelligent terminal units. The OBDH protocol shall provide a standard user friendly interface by which intelligent users of the OBDH bus may send and receive messages. The definition of this underlying mechanism, its formal verification, and an assessment of the tests to perform to validate it are summarized. The procotol was defined by an improvement of the previous OBDH protocol and was

supported by an ISO-like structure in layers. It led to an expression of the protocol in state-diagrams and in current language. Its formal verification was performed with Petri net techniques, supported by dedicated software tools. The formal verification allowed to check the protocol and point out overspecified features. A test plan of the protocol is proposed. ESA

**N87-27440#** Politecnico di Milano (Italy). Dipt. di Elettronica.
**AN EXERCISE ON THE SPECIFICATION OF REAL-TIME SYSTEMS USING LOGIC PROGRAMMING**
F. Garzotto, C. Ghezzi, D. Mandrioli, and A. Morzenti 1986 32 p Sponsored by CNR and the Ministero della Pubblica Istruzione
(Rept-86-031; ETN-87-90063) Avail: NTIS HC A03/MF A01

The need for applying logic programming to the specification of real-time systems, i.e., systems which must react to external asynchronous stimuli within strict time bounds, is discussed. A methodology and an environment to support specification, design, and validation of such time critical systems is needed. Ways in which time can be explicitly taken into account in the specification; which methodology to use to decompose the system into logical modules; and how the logic specification can be used for prototyping and proving properties of the specified real-time system are described. ESA

**N87-27441#** Politecnico di Milano (Italy). Dipt. di Elettronica.
**A NEW APPROACH TO INTEGRATION TESTING OF LARGE-SCALE SOFTWARE PACKAGES**
Vincenzo Piuri 1987 47 p
(Rept-87-006; ETN-87-90064) Avail: NTIS HC A03/MF A01

Integration testing of software modules into large scale packages using a system model and error classes built from the source code of the package is described. Coverage and ambiguity are defined with respect to error classes; operators are defined and related to error spaces. Test sequences are constructed on operator ordering. Criteria to define single sequences and their concatenation into a test procedure to maximize error coverage and minimize ambiguity are proposed. Theorems to identify the best test procedure for the overall system are proved. A Petri net model of test actions and procedures allows an easy identification of the optimum test procedure. ESA

# 62 COMPUTER SYSTEMS

Includes computer networks and special application computer systems.

**N87-27442#** Yale Univ., New Haven, Conn. Dept. of Computer Science.
**PARLANCE: A PARA-FUNCTIONAL PROGRAMMING ENVIRONMENT FOR PARALLEL AND DISTRIBUTED COMPUTING**
Paul Hudak, Jean-Marc Delosme, and Ilse C. Ipsen Mar. 1987 37 p
(Contracts DAAL03-86-K-0158; DE-FG02-86ER-25012; N00014-85-K-0461; Grant NSF DCR-84-51415)
(AD-A180847; YALEU/DCS/RR-524) Avail: NTIS HC A03/MF A01 CSCL 09B

This paper outlines the beginning of a collaborative research effort whose overall goal is the development of an effective parallel programming environment called ParLance, consisting of a para-functional language, highly-optimizing compiler, parallel evaluation kernel, and interactive support for parallel program development. ParLance is intended to be relatively machine independent, with implementations planned for both a shared memory (ENCORE MultiMax) and a distributed-memory (INTEL iPSC) multiprocessor. Other machines to be considered include the Connection Machine and the WARP at CMU. GRA

**N87-27443*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**MASS STORAGE SYSTEMS FOR DATA TRANSPORT IN THE EARLY SPACE STATION ERA 1992-1998**
Richard Carper, ed., John Dalton, ed., Mike Healey, ed., Linda Kempster, ed., John Martin, ed. (Computer Technology Associates, Inc., Lanham, Md.), Fred McCaleb, ed., Stanley Sobieski, ed., and John Sos, ed. Jul. 1987 112 p
(NASA-TM-87826; Rept-87B0343; NAS 1.15:87826) Avail: NTIS HC A06/MF A01 CSCL 09B

NASA's Space Station Program will provide a vehicle to deploy an unprecedented number of data producing experiments and operational devices. Peak down link data rates are expected to be in the 500 megabit per second range and the daily data volume could reach 2.4 terabytes. Such startling requirements inspired an internal NASA study to determine if economically viable data storage solutions are likely to be available to support the Ground Data Transport segment of the NASA data system. To derive the requirements for data storage subsystems, several alternative data transport architectures were identified with different degrees of decentralization. Data storage operations at each subsystem were categorized based on access time and retrieval functions, and reduced to the following types of subsystems: First in First out (FIFO) storage, fast random access storage, and slow access with staging. The study showed that industry funded magnetic and optical storage technology has a reasonable probability of meeting these requirements. There are, however, system level issues that need to be addressed in the near term. Author

**N87-27444*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**AUTOMATED PROBLEM SCHEDULING AND REDUCTION OF SYNCHRONIZATION DELAY EFFECTS Final Report**
Joel H. Saltz Jul. 1987 38 p Submitted for publication Prepared in cooperation with Yale Univ., New Haven, Conn.
(Contract NAS1-18107)
(NASA-CR-178336; ICASE-87-22; NAS 1.26:178336) Avail: NTIS HC A03/MF A01 CSCL 09B

It is anticipated that in order to make effective use of many future high performance architectures, programs will have to exhibit at least a medium grained parallelism. A framework is presented for partitioning very sparse triangular systems of linear equations that is designed to produce favorable preformance results in a wide variety of parallel architectures. Efficient methods for solving these systems are of interest because: (1) they provide a useful model problem for use in exploring heuristics for the aggregation, mapping and scheduling of relatively fine grained computations whose data dependencies are specified by directed acrylic graphs, and (2) because such efficient methods can find direct application in the development of parallel algorithms for scientific computation. Simple expressions are derived that describe how to schedule computational work with varying degrees of granularity. The Encore Multimax was used as a hardware simulator to investigate the performance effects of using the partitioning techniques presented in shared memory architectures with varying relative synchronization costs. Author

**N87-27445#** Sandia National Labs., Albuquerque, N. Mex.
**APOLLO RING OPTICAL SWITCH**
J. H. Maestas Mar. 1987 41 p
(Contract DE-AC04-76DP-00789)
(DE87-010157; SAND-87-0037) Avail: NTIS HC A03/MF A01

An optical switch was designed, built, and installed at Sandia National Laboratories in Albuquerque, New Mexico, to facilitate the integration of two Apollo computer networks into a single network. This report presents an overview of the optical switch as well as its layout, switch testing procedure and test data, and installation. DOE

**N87-27446*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.
**IMPLEMENTATION OF AN ADI METHOD ON PARALLEL COMPUTERS Final Report**

Raad A. Fatoohi and Chester E. Grosch Jul. 1987 28 p Submitted for publication Prepared in cooperation with Old Dominion Univ., Norfolk, Va.
(Contract NAS1-18107)
(NASA-CR-178337; ICASE-87-43; NAS 1.26:178337) Avail: NTIS HC A03/MF A01 CSCL 09B

The implementation of an ADI method for solving the diffusion equation on three parallel/vector computers is discussed. The computers were chosen so as to encompass a variety of architectures. They are: the MPP, an SIMD machine with 16K bit serial processors; FLEX/32, an MIMD machine with 20 processors; and CRAY/2, an MIMD machine with four vector processors. The Gaussian elimination algorithm is used to solve a set of tridiagonal systems on the FLEX/32 and CRAY/2 while the cyclic elimination algorithm is used to solve these systems on the MPP. The implementation of the method is discussed in relation to these architectures and measures of the performance on each machine are given. Simple performance models are used to describe the performance. These models highlight the bottlenecks and limiting factors for this algorithm on these architectures. Finally, conclusions are presented. Author

# 63 CYBERNETICS

Includes feedback and control theory, artificial intelligence, robotics and expert systems.

For related information see also *54 Man/System Technology and Life Support.*

**N87-27447*#** Old Dominion Univ., Norfolk, Va. Dept. of Computer Science.
**ANALYSIS AND SYNTHESIS OF ABSTRACT DATA TYPES THROUGH GENERALIZATION FROM EXAMPLES**
Christian Wild [1987] 23 p
(Grant NAG1-439)
(NASA-CR-180976; NAS 1.26:180976; TR-87-004) Avail: NTIS HC A02/MF A01 CSCL 09B

The discovery of general patterns of behavior from a set of input/output examples can be a useful technique in the automated analysis and synthesis of software systems. These generalized descriptions of the behavior form a set of assertions which can be used for validation, program synthesis, program testing and run-time monitoring. Describing the behavior is characterized as a learning process in which general patterns can be easily characterized. The learning algorithm must choose a transform function and define a subset of the transform space which is related to equivalence classes of behavior in the original domain. An algorithm for analyzing the behavior of abstract data types is presented and several examples are given. The use of the analysis for purposes of program synthesis is also discussed. Author

**N87-27448#** Army Armament Research and Development Command, Watervliet, N. Y. Weapons Lab.
**NON-LIVING INTELLIGENCE Final Technical Report**
Mark Johnson and Raymond D. Scanlon Apr. 1987 20 p
(AD-A180637; ARCCB-TR-87009) Avail: NTIS HC A02/MF A01 CSCL 09B

The science of constructing machines that think using the brain as a model is called non-living intelligence (NLI). This report investigates the origins of NLI and discusses recent progress in the field. A computer simulation has been developed which exhibits the behavior of a primitive organism capable of adapting and surviving. The program is used to demonstrate learning using the hypothesis of synaptic plasticity. A neural network consisting entirely of sensory and motor neurons models the reward mechanism of the vertebrate brain. GRA

**N87-27449#** Systran Corp., Dayton, Ohio.
**HARDWARE REALIZATION OF ADAPTIVE NETWORKS Final Report, 2 Jan. 1984 - 30 Sep. 1986**
Barry C. Deer May 1987 154 p
(Contract F33615-84-C-1432)
(AD-A180649; AFWAL-TR-87-1005) Avail: NTIS HC A08/MF A01 CSCL 09B

This technical report presents the results of research conducted to examine the problems and issues of implementing adaptive network software in a hardware system. In prior work, SYSTRAN conducted studies of adaptive networks as computer simulations. In this project those software algorithms were further developed and hosted on a customized multiprocessor system. The resulting prototype hardware was demonstrated to achieve all the capabilities of the software simulations. This report discusses the research approach, design and results, and future expectations. The benefit of this research is to move adaptive network technology closer to Air Force applications. GRA

**N87-27450*#** Rice Univ., Houston, Tex. Dept. of Electrical Engineering.
**A FRAMEWORK FOR PARALLELISM IN FRAME-BASED REASONING**
Henry K. Wang and Rui J. DeFigueiredo 1987 20 p
(Contracts NAS9-17145; N00014-85-K-0152)
(NASA-CR-180998; NAS 1.26:180998; AD-A180986) Avail: NTIS HC A02/MF A01 CSCL 09B

This paper discusses issues of parallelism within frame-based reasoning systems. This effort was motivated by our recent work on intelligent signal processing and visual pattern recognition. Although rule-based systems prevail as knowledge engineering tools, we chose frame-based systems because they provide a sound knowledge representation scheme (including declarative and procedural knowledge) and a powerful (distributed) inference engine. We look at a frame-based system developed at Rice University and NASA/JSC called WenLy which is composed Wen, representing declarative knowledge, and Ly, representing procedural knowledge and taking charge of inference. Then we examine two approaches to achieve parallelism within that system. One is called the programming approach in which we implement the frames on a parallel Lisp language. The order is called the architectural approach which supports MIMD computers with uniformed memory space. It is obvious that the list structure is a bottleneck to parallelism; on the other hand, it is crucial to frame-based reasoning due to its flexibility and uniformity.
Author (GRA)

**N87-27451#** Massachusetts Inst. of Tech., Cambridge. Artificial Intelligence Lab.
**AMBIGUITIES OF A MOTION FIELD**
Shahriar Negahdaripour Jan. 1987 21 p
(Contract N00014-75-C-0643)
(AD-A181200; AI-M-940) Avail: NTIS HC A02/MF A01 CSCL 09B

Conditions are studied under which a perspective motion field can have multiple interpretations and present analytical expressions for the relationship among these interpretations. Furthermore, in most cases, the ambiguity in the interpretation of a motion field can be resolved by imposing the physical constraint that depth is positive over the image region onto which the surface projects.
GRA

**N87-27452#** University of Southern California, Marina del Rey. Information Sciences Inst.
**RHETORICAL STRUCTURE THEORY: A FRAMEWORK FOR THE ANALYSIS OF TEXTS**
William C. Mann and Sandra A. Thompson Apr. 1987 30 p
(Grant NSF IST-84-08726)
(AD-A181350; ISI/RS-87-185) Avail: NTIS HC A03/MF A01 CSCL 05G

Rhetorical Structure Theory is a theory of text organization which provides a framework for an analysis of text. The theory is based on the understanding that a text is not merely a string of clauses, but consists instead of hierarchically organized groups of clauses that stand in various relations to one another. These rhetorical relations can be described functionally in terms of the purposes of the writer and the writer's assumptions about the reader. They hold between two adjacent parts of a text, where,

typically, one part is nuclear and one a satellite. An analysis of a text consists in identifying the relations holding between successively larger parts of the text, yielding a natural hierarchical description of the rhetorical organization of the text. The paper informally outlines RST's mechanisms and applications, which include studies of clause combining, coherence and assertional effects of discourse structure. RST characteristically provides comprehensive analyses rather than selective commentary. RST is insensitive to text size, and has been applied to a wide variety of sizes of text. GRA

**N87-27453#** Naval Postgraduate School, Monterey, Calif.
**A PARALLEL STRUCTURE FOR ON LINE IDENTIFICATION AND ADAPTIVE CONTROL M.S. Thesis**
Yong H. Kim Mar. 1987 75 p
(AD-A181748) Avail: NTIS HC A04/MF A01 CSCL 09B

We investigated the possibility of employing parallel computing structures for adaptive identification and control. The identification algorithm is based on recursive least-squares with covariance resetting and block processing technique. It is shown how a parallel processing structure can be obtained by recursively applying Givens Rotation to the data matrix. Due to the regularity of its structure the approach presented is particularly attractive for VLSI implementation. GRA

**N87-27454#** Oak Ridge National Lab., Tenn.
**ADVANCES IN CONCURRENT COMPUTATION FOR MACHINE INTELLIGENCE AND ROBOTICS**
J. Barhen, J. R. Einstein, and C. C. Jorgensen 1987 15 p
Presented at the 2nd International Conference on Supercomputing, San Francisco, Calif., 4 May 1987
(Contract DE-AC05-84OR-21400)
(DE87-007666; CONF-870567-2; CESAR-87/10) Avail: NTIS HC A02

New methodologies must be developed for effective use of hypercube multiprocessors to meet the special requirements of Intelligent Robotics concerned with time-critical applications. The aim of this paper is to provide an overview of our initial experiences in this area, focusing on multiprocessor load-balance, mobile robotics and neural network algorithms. DOE

**N87-27455*#** National Aeronautics and Space Administration, Washington, D.C.
**CONTROLLER DESIGN FOR THE IMPROVEMENT OF FEEDBACK PROPERTIES: A METHOD FOR TUNING THE WEIGHT IN THE EVALUATION FUNCTION OF THE LQG THEORY**
Masami Saeki, Hui-Zhong Li, and Kazuaki Ando Aug. 1987 24 p Transl. into ENGLISH from Fuiidobakku Tokusei wo Kojo Suru Seigyo Kei Sekkei: LQG Riron no Hyokakansu Omomi no Seiriho, Keisoku Jido Seigyo Gakki Ronbunshu (Japan), v. 22, no. 4, Apr. 1986 p 9-16 Transl. by Kanner (Leo) Associates, Redwood City, Calif. Original document was prepared by Tsukuba Univ., Japan
(Contract NASw-4005)
(NASA-TT-20027; NAS 1.77:20027) Avail: NTIS HC A02/MF A01 CSCL 09B

In the controller design of a linear time-invariant system, it is important to improve the feedback properties such as robust stability and sensitivity. In the multi-input multi-output case, these properties can be estimated by using the singular values of return difference matrix. The design method to obtain better singular-value-points is desired. How to tune the weight matrix of performance index and/or covariance matrix of noise in the Linear Quadratic Gaussian (LQC) theory to get a desired singular-value-plot was studied. First, the property of singular-value plots of return difference matrix of a system designed by LQG theory is examined from the viewpoint of tuning weight. Second, a distance between real singular-value-plots and a desired plot is defined, and the weight of performance index is numerically determined by quasi-Newton method so that the distance is minimized. Author

**N87-27456#** Sheffield Univ. (England). Dept. of Control Engineering.
**OPTIMAL CONTROL OF DISTRIBUTED BILINEAR SYSTEMS**
S. P. Banks Oct. 1986 12 p
(RR-301; ETN-87-90098) Avail: NTIS HC A02/MF A01

The optimal control problem for a bilinear distributed parameter system subject to a quadratic cost functional is solved. It is shown that the optimal control is given by a convergent power series in the state with tensor coefficients. ESA

# 64 NUMERICAL ANALYSIS

Includes iteration, difference equations, and numerical approximation.

**N87-27457*#** Mississippi State Univ., Mississippi State. Dept. of Aerospace Engineering.
**TRANSFORMATION OF TWO AND THREE-DIMENSIONAL REGIONS BY ELLIPTIC SYSTEMS Semiannual Status Report, 15 May - 14 Nov. 1986**
C. Wayne Mastin and Joe F. Thompson 12 Dec. 1986 10 p
(Grant NsG-1577)
(NASA-CR-180323; NAS 1.26:180323) Avail: NTIS HC A02/MF A01 CSCL 12A

Grid smoothing and orthogonalization procedures were developed and implemented in the construction of two and three dimensional grids. The procedures are based on the variational methods of grid generation. The two-dimensional examples were computed using the MSU IRIS Graphics Workstation. It was demonstrated that the elliptic grid generation equations, with arbitrary forcing functions, can be solved, in their variational formulation, using a gradient method. Since gradient methods have a global convergence property, the divergence problems often encountered when using SOR iterative methods can be avoided. It is not to be concluded, however, that SOR methods should be abandoned, since gradient methods tend to converge very slowly. In fact, slow convergence was the major problem encountered in the three-dimensional grids. Further progress was made on the continuing effort to develop conservative interpolation formulas for overlapping grids. B.G.

**N87-27458*#** Old Dominion Univ., Norfolk, Va. Dept. of Mechanical Engineering and Mechanics.
**A TAYLOR-GALERKIN FINITE ELEMENT ALGORITHM FOR TRANSIENT NONLINEAR THERMAL-STRUCTURAL ANALYSIS Progress Report, 1 Jan. - 1 Jun. 1985**
Earl A. Thornton and Pramote Dechaumphai Jul. 1985 23 p
(Grant NsG-1321)
(NASA-CR-180552; NAS 1.26:180552) Avail: NTIS HC A02/MF A01 CSCL 12A

A Taylor-Galerkin finite element solution algorithm for transient nonlinear thermal-structural analysis of large, complex structural problems subjected to rapidly applied thermal-structural loads is described. The two-step Taylor-Galerkin algorithm is an application of an algorithm recently developed for problems in compressible fluid dynamics. The element integrals that appear in the algorithm can be evaluated in closed form for two and three dimensional elements. Author

**N87-27459#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**NONLINEAR PARTIAL DIFFERENTIAL EQUATIONS AND INVARIANT DIFFERENTIAL SYSTEMS Final Report, 24 Oct. 1984 - 23 Oct. 1986**
Frank B. Estabrook and Hugo D. Wahlquist 1 May 1987 4 p
(Contract MIPR-ARO-116-85)
(AD-A180624; ARO-21848.5-MA) Avail: NTIS HC A02/MF A01 CSCL 12A

Partial differential equations arise in all fields of science and engineering, yet, when these equations are nonlinear, systematic methods for their solution are usually not known. Sometimes further integrability or consistency conditions are implied. Sometimes a

changes of coordinates can help greatly - even to uncovering hidden linearity. Sometimes subfamilies of solutions (e.g., similarity solutions) can be found which still have sufficient generality to be useful for the engineering or scientific problem at hand. Sometimes special solutions such as solitons exist which cannot have been guessed at perturbative methods, and which turn out to be fundamental and (in a nonlinear way) superimpossible. All these approaches, and many others, all seemingly disparate and ad hoc, can be systematically treated by a so-called geometric approach to partial differential equations initiated almost 50 years ago by Elie Cartan in France. This geometric approach has been little used until recently, as it has still seemed abstract to applied mathematicians. The goal of this research was to formulate and apply geometric methods, and to further their use as a tool of applied mathematics and (in possible discrete versions) computing. GRA

**N87-27460#** Wisconsin Univ., Madison. Mathematics Research Center.
**CONSTRUCTION OF PROCESS-DIFFERENTIABLE REPRESENTATIONS FOR PARAMETRIC FAMILIES OF DISTRIBUTIONS Technical Summary Report**
Peter W. Glynn Feb. 1987 17 p
(Contract DAAG29-80-C-0041; Grant NSF ECS-84-04809)
(AD-A180749; MRC-TSR-2972) Avail: NTIS HC A02/MF A01 CSCL 12A

Sensitivity analysis for stochastic systems plays an important role in the statistical study of such systems, and in the optimization of stochastic processes this paper considers questions related to the efficient computation of Monte Carlo estimates for the derivatives corresponding to such systems. These derivatives play a crucial part in the development of numerical schemes for accomplishing the statistical analysis and optimization mentioned above. GRA

**N87-27461#** Naval Postgraduate School, Monterey, Calif.
**RECENT ADVANCES IN THE APPROXIMATION OF SURFACES FROM SCATTERING DATA Technical Report, Oct. - Dec. 1986**
Richard Franke Apr. 1987 37 p
(AD-A180767; NPS-53-87-001) Avail: NTIS HC A03/MF A01 CSCL 12B

This report discusses advances in the mathematical theory behind Hardy's multiquadric method, development of methods for surfaces with tension parameters or which satisfy constraints, and methods for least squares approximation and subset selection. This report was prepared for the proceedings of The International Workshop on Multivariate Approximation, in December 1986. GRA

**N87-27462#** Wisconsin Univ., Madison. Mathematics Research Center.
**B-FORM BASICS Technical Summary Report**
C. DeBoor Sep. 1986 24 p
(Contract DAAG29-80-C-0041)
(AD-A180769; MCR-TSR-2957) Avail: NTIS HC A02/MF A01 CSCL 12A

The basic facts about the B(arycentric, -ernstein, -ezier) form of a multivariate polynomial are recorded and, in part, proved. These include: evaluation (de Casteliau's algorithm), differentiation and integration, product, degree raising, change of the underlying simplex, and the behavior on the boundary of the underlying simplex, with application to the construction of smooth pp functions on a given triangulation. Some effort has gone into making the notation fully reflect the symmetries and structure of this form. In particular, the description of this form in terms of difference operators is stressed. GRA

**N87-27463#** Wisconsin Univ., Madison. Mathematics Research Center.
**REVERSED STABILITY CONDITIONS IN TRANSIENT FINITE ELEMENT ANALYSIS Technical Summary Report**
David S. Malkus, Michael E. Plesha, and Meng-Ru Liu Feb. 1987 24 p
(Contract DAAG29-80-C-0041; Grant AF-AFOSR-0141-85)
(AD-A180794; MRC-TSR-2971) Avail: NTIS HC A02/MF A01 CSCL 20D

Numerical methods which introduce artificially unstable modes are discussed. In structural and elastodynamics these result from optimal mass lumping with higher-order elements. In fluid mechanics an additional source of these modes can be a penalty function with alternating signs. These modes yield unstable modal equations; however, they do not necessarily imply unstable transient integration in the presence of algorithmic damping. Stable integration can be achieved by satisfying a stability condition in which the roles of space-step and time-step are reversed. GRA

**N87-27464#** Northwestern Univ., Evanston, Ill. Technological Inst.
**PENETRATION MECHANICS WITH AN ARBITRARY LAGRANGIAN EULERIAN FINITE ELEMENT CODE Final Report, 1 May 1984 - 31 Jan. 1987**
Ted Belytschko and Wing K. Liu 15 Apr. 1987 5 p
(Contract DAAG29-84-K-0057)
(AD-A180795; ARO-21048.8-MA) Avail: NTIS HC A02/MF A01 CSCL 12A

Methodologies for Arbitrary Lagrangian Eulerian (ALE) formulations for the treatment of penetration problems are studied. These methods are attractive because they would permit far more economical simulation of penetration problems by avoiding the extreme crushing of the elements at the penetrator/target interface. Previous to these developments, computer simulations of two and three dimension problems are so time-consuming (2 to 24 hours on the largest computer) that they cannot be made within the normal framework of engineering analysis and decision making. These methods offer the potential of an order of magnitude reductions in running time. Five aspects of ALE formulations are studied: the convergence and stability of multitime step (subcycling) algorithms, development of ALE constitutive laws which are derivable from Lagrangian constitutive equations, and development of mapping procedures for the mesh so that excessive distortion is avoided. In the research program, these aspects are studied in conjunction with realistic computations of two dimensional penetration problems. GRA

**N87-27465#** Utah Univ., Salt Lake City. Dept. of Chemistry.
**ERROR ESTIMATION USING THE SIMPLEX METHOD IN NONLINEAR LEAST SQUARES DATA ANALYSIS**
Gregory R. Phillips and Edward M. Eyring 17 Jun. 1987 27 p
(Contract N00014-86-K-0639)
(AD-A181834; TR-1) Avail: NTIS HC A03/MF A01 CSCL 12A

The simplex method is a widely-used technique in analytical chemistry. Although primarily viewed as a technique for experimental optimization, this method is also used for mathematical modeling, such as nonlinear least squares curve fitting. Acceptable methods of chemical data analysis require estimates of both the parameter values and their errors - something which is not provided by current simplex algorithms. This paper proposes a procedure for obtaining error estimates of the fitted parameters. The proposed method can be easily implemented on a laboratory minicomputer, greatly enhancing the utility of the simplex method to analytical chemists. This procedure is first described for a general function, and then illustrated using a data set from the literature. GRA

**N87-27466#** Vibration Inst., Clarendon Hills, Ill.
**THE SHOCK AND VIBRATION DIGEST, VOLUME 19, NO. 8 Monthly Report**
Judith Nagle-Eshleman, ed. Aug. 1987 72 p
Avail: NTIS HC A04/MF A01

Research of interest to the Shock and Vibration science community is presented. The feature article is entitled: On integrating a logarithmic or semilogarithmic linear power spectral density plot of a random variable X(T): Part 3. Also presented are various book reviews and abstracts from the current literature. For individual titles, see N87-27467 through N87-27467.

**N87-27467#** Wyle Labs., Inc., Huntsville, Ala.
**ON INTEGRATING A LOGARITHMIC OR SEMILOGARITHMIC PIECEWISE LINEAR PSD PLOT OF A RANDOM VARIABLE X(T): PART 3**
R. E. Doyle *In* Vibration Inst., The Shock and Vibration Digest, Volume 19, No. 8 Aug. 1987 p 5-13 (For primary document see N87-27466 21-64)
Avail: NTIS HC A04/MF A01

Formulas for integrating a piecewise linear power spectral density (PSD) plot, to obtain the composite rms value, are derived and tabulated for three analytically distinct cases. Presented in three parts, part 1 treats case 1: a logarithmic plot with the W and f scales both logarithmic. Part 2 treats case 2 and case 3: case 2 is a semilogarithmic plot with the W scale logarithmic and the f scale uniform; case 3 is a semilogarithmic plot with the W scale uniform and the f scale logarithmic. Part 3 presents numerical examples illustrating the three cases. A comparative study of the results obtained provides insight into PSD plots in general. Integration errors and the effect of different scales on the composite rms value are examined. The treatment is general, expository and applicable to the design and analysis of structures and equipment subjected to random vibration environments. Author

**N87-27468#** Gosudarstvennyi Komitet po Ispolzovaniyu Atomnoi Energii, Serpukhov (USSR).
**INTERNAL SYMMETRY ALGEBRA OF EXACTLY INTEGRABLE DYNAMIC SYSTEMS IN QUANTUM REGION**
A. N. Leznov and M. A. Mukhtarov 1986 9 p In RUSSIAN
(DE87-702159; IFVE-OTF-86-84) Avail: NTIS (US Sales Only) HC A02/MF A01

It is shown on the example of two-dimensional generalized Toda lattice that semi-simple Lie algebras of the classical problem reduce in quantum region to associative Hopf algebras. The latter ones were arised in Drinfeld's paper as quantum algebras. The Heisenberg operators of the interacting field as functions of in-field are expressed in terms of the quantum algebras via the classical theory formulas. Here the previously obtained expressions for these operators get simple algebraic sense. DOE

**N87-27469*#** Hawaii Univ., Manoa. Dept. of Electrical Engineering.
**SERIAL-PARALLEL MULTIPLICATION IN GALOIS FIELDS**
Shu Lin 26 Aug. 1987 11 p
(Grant NAG5-931)
(NASA-CR-181210; NAS 1.26:181210; TR-2) Avail: NTIS HC A02/MF A01 CSCL 12A

A method for multiplying two elements from the Galois field GF(2 sup ms) is presented. This method provides a tradeoff between speed and complexity. Author

**N87-27470*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**COMPARATIVE STUDY OF HIGH-RESOLUTION SHOCK-CAPTURING SCHEMES FOR A REAL GAS**
J.-L. Montagne, H. C. Yee, and M. Vinokur (Sterling Software, Palo Alto, Calif.) Jul. 1987 37 p Presented at the 7th GAMM Conference on Numerical Methods in Fluid Mechanics, Louvain-la-Neuve, Belgium, 9-11 Sep. 1987
(NASA-TM-100004; A-87274; NAS 1.15:100004) Avail: NTIS HC A03/MF A01 CSCL 12A

Recently developed second-order explicit shock-capturing methods, in conjunction with generalized flux-vector splittings, and a generalized approximate Riemann solver for a real gas are studied. The comparisons are made on different one-dimensional Riemann (shock-tube) problems for equilibrium air with various ranges of Mach numbers, densities and pressures. Six different Riemann problems are considered. These tests provide a check on the validity of the generalized formulas, since theoretical prediction of their properties appears to be difficult because of the non-analytical form of the state equation. The numerical results in the supersonic and low-hypersonic regimes indicate that these produce good shock-capturing capability and that the shock resolution is only slightly affected by the state equation of equilibrium air. The difference in shock resolution between the various methods varies slightly from one Riemann problem to the other, but the overall accuracy is very similar. For the one-dimensional case, the relative efficiency in terms of operation count for the different methods is within 30%. The main difference between the methods lies in their versatility in being extended to multidimensional problems with efficient implicit solution procedures. Author

**N87-27471#** Politecnico di Milano (Italy). Dipt. di Elettronica.
**FAULT-TOLERANT SOLUTIONS FOR COMPLEX-NUMBERS MULTIPLIERS**
F. C. Bonzio, M. G. Sami, and G. StortiGajani 1986 14 p
(Rept-86-028; ETN-87-90062) Avail: NTIS HC A02/MF A01

Two multipliers for complex numbers are presented, both characterized by reduced redundancy. The first solution provides self-testing, and survival of a single fault through reconfiguration, while the second solution provides self-testing (reconfiguration can be achieved, but with added difficulty). Redundancy is evaluated parametrically; error latency is plotted for various instances of input data lengths. ESA

# 65 STATISTICS AND PROBABILITY

Includes data sampling and smoothing; Monte Carlo method; and stochastic processes.

**N87-27472#** Naval Postgraduate School, Monterey, Calif.
**SMOOTHNESS PRIORS IN TIME SERIES**
Will Gersch and Genshiro Kitagawa Apr. 1987 57 p
(AD-A180892; NPS55-87-004) Avail: NTIS HC A04/MF A01 CSCL 12A

A variety of time series signal extraction/smoothing problems is considered from a Bayesian smoothness priors point of view. The origin of the subject is a smoothing problem posed by Whittaker (1923). Using a stochastic regression-linear model Gaussian disturbances framework, we model stationary time series and nonstationary mean and nonstationary covariance time series. Smoothness priors distributions on the model parameters are expressed either in terms of time domain stochastic difference equation or frequency domain constraints. A small number of (hyper)parameters specify very complex time series behavior. The critical computation is the likelihood of the Bayesian model. Finally we show a smoothness priors state space-not necessarily Gaussian-not necessarily linear model of nonstationary time series. Author (GRA)

**N87-27473#** Wisconsin Univ., Madison. Mathematics Research Center.
**IDENTIFICATION OF ACTIVE FACTORS IN UNREPLICATED FRACTIONAL FACTORIAL EXPERIMENTS Technical Summary Report**
R. Daniel Meyer and George Box Nov. 1986 27 p
(Contract DAAG29-80-C-0041; Grant NSF DMS-84-20968)
(AD-A181280; MRC-TSR-2959) Avail: NTIS HC A03/MF A01 CSCL 12A

Box and Meyer proposed a method for analyzing unreplicated factorial experiments in which contrasts too large to be attributed to noise are identified. It then remains to associate supposed active contrasts with experimental factors, either as main effects or interactions. This article explores a modification of the Box and Meyer method which allows it to be used for this purpose. The analysis is shown to take the confounding structure of the design into account when assessing the activity of each factor. In addition, the sensitivity of the analysis to various assumptions is explored. GRA

**N87-27474*#** National Aeronautics and Space Administration. Marshall Space Flight Center, Huntsville, Ala.
**PROBABILISTIC RISK ANALYSIS OF FLYING THE SPACE SHUTTLE WITH AND WITHOUT FUEL TURBINE DISCHARGE TEMPERATURE REDLINE PROTECTION**

Leonard Howell Aug. 1987 22 p
(NASA-TP-2759; NAS 1.60:2759) Avail: NTIS HC A02/MF A01 CSCL 12A

An exact mathematical model is presented of the Space Shuttle Main Engine computer voting logic in the presence of High Pressure Fuel Turbine (HPFT) overtemperature events and fuel turbine temperature sensor failures. The model provides estimates of the probability of erroneous engine shutdown and the probability of not detecting a HPFT overtemperature event. Because it is believed that the likelihood of sensor failures and overtemperature events in the HPFT greatly overshadows those in the High Pressure Oxygen Turbine (HPOT), this modeling effort focused on the HPFT. However, because the redline protection logic is the same for both turbines, estimation of the model parameters using relevant HPOT data would provide estimates of the risk of erroneous engine shutdown and an undetected overtemperature event in the HPOT. Because of the complexity of the model, it was necessary to program the solution which thus makes it feasible to accommodate a changing data base. This is considered to be of great interest because of the subjective nature in determining the relevancy of certain failures and the fact that the data base is constantly changing as a result of the frequent engine tests. Author

# 66 SYSTEMS ANALYSIS

Includes mathematical modeling; network analysis; and operations research.

**N87-27475*#** The Futures Group, Glastonbury, Conn.
**NASA LEWIS RESEARCH CENTER FUTURING WORKSHOP Final Report**
Mark Boroush, John Stover, and Charles Thomas Jan. 1987 156 p Workshop held in Cleveland, Ohio, 21-22 Oct. 1986
(NASA Order C-21030)
(NASA-CR-179577; NAS 1.26:179577) Avail: NTIS HC A08/MF A01 CSCL 12B

On October 21 and 22, 1986, the Futures Group ran a two-day Futuring Workshop on the premises of NASA Lewis Research Center. The workshop had four main goals: to acquaint participants with the general history of technology forecasting; to familiarize participants with the range of forecasting methodologies; to acquaint participants with the range of applicability, strengths, and limitations of each method; and to offer participants some hands-on experience by working through both judgmental and quantitative case studies. Among the topics addressed during this workshop were: information sources; judgmental techniques; quantitative techniques; merger of judgment with quantitative measurement; data collection methods; and dealing with uncertainty. Author

**N87-27476*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**AN ALGEBRAIC CRITERION FOR THE ONSET OF CHAOS IN NONLINEAR DYNAMIC SYSTEMS**
A. Unal and M. Tobak Aug. 1987 23 p
(NASA-TM-89457; A-87201; NAS 1.15:89457) Avail: NTIS HC A02/MF A01 CSCL 12B

The correspondence between iterated integrals and a noncommutative algebra is used to recast the given dynamical system from the time domain to the Laplace-Borel transform domain. It is then shown that the following algebraic criterion has to be satisfied for the outset of chaos: the limit (as tau approaches infinity and x sub 0 approaches infinity) of ((sigma(k=0) (tau sup k) / (k* x sub 0 sup k)) G ll G = 0, where G is the generating power series of the trajectories, the symbol ll is the shuffle product (le melange) of the noncommutative algebra, x sub 0 is a noncommutative variable, and tau is the correlation parameter. In the given equation, symbolic forms for both G and ll can be obtained by use of one of the currently available symbolic languages such as PLI, REDUCE, and MACSYMA. Hence, the criterion is a computer-algebraic one. M.G.

**N87-27477*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.
**ADAPTIVE CONTROL AND NOISE SUPPRESSION BY A VARIABLE-GAIN GRADIENT ALGORITHM**
S. J. Merhav (Israel Inst. of Tech., Haifa.) and R. S. Mehta Jun. 1987 43 p
(NASA-TM-89453; A-87191; NAS 1.15:89453) Avail: NTIS HC A03/MF A01 CSCL 12B

An adaptive control system based on normalized LMS filters is investigated. The finite impulse response of the nonparametric controller is adaptively estimated using a given reference model. Specifically, the following issues are addressed: The stability of the closed loop system is analyzed and heuristically established. Next, the adaptation process is studied for piecewise constant plant parameters. It is shown that by introducing a variable-gain in the gradient algorithm, a substantial reduction in the LMS adaptation rate can be achieved. Finally, process noise at the plant output generally causes a biased estimate of the controller. By introducing a noise suppression scheme, this bias can be substantially reduced and the response of the adapted system becomes very close to that of the reference model. Extensive computer simulations validate these and demonstrate assertions that the system can rapidly adapt to random jumps in plant parameters. Author

# 67 THEORETICAL MATHEMATICS

Includes topology and number theory.

**N87-27478#** Illinois Univ., Urbana. Dept. of Computer Science.
**ON OBTAINING A CONSISTENT SET OF INITIAL VALUES FOR A SYSTEM OF DIFFERENTIAL-ALGEBRAIC EQUATIONS**
B. J. Leimkuhler, L. R. Petzold (Lawrence Livermore National Lab., Calif.), and C. W. Gear May 1987 44 p
(Contract DE-FG02-87ER-25026)
(DE87-010572; DOE/ER-25026/5; UILU-ENG-87-1732; UIUCDCS-R-87-1344) Avail: NTIS HC A03/MF A01

Discussed are some of the difficulties in designing a general algorithm for determining a consistent initial vector for a differential algebraic equation (DAE) when only part of the vector is known. A set of relations (the consistency equations) is derived which an initial vector should satisfy in order for there to be a smooth solution through the point which is also consistent with known initial data. An approximation to one of the individual derivative equations was constructed, and the solution of the resulting system of approximated consistency equations was considered. In particular, it was noted that the system does not admit an exact solution so that some sort of least-squares approximation is called for. Some preliminary numerical experiments were described. These experiments tend to validate concepts discussed, although they are too limited in scope to suggest anything more meaningful. Two critical obstacles prevent the implementation of these ideas: a method must be found to efficiently solve (in the least-squares sense) a large system of overdetermined nonlinear equations with a sparse, rank-deficient Jacobian, and there is the need for an error estimation and control mechanism which can adjust various parameters to meet a required accuracy. DOE

# 70 PHYSICS (GENERAL)

For precision time and time interval (PTTI) see *35 Instrumentation and Photography;* for geophysics, astrophysics or solar physics see *46 Geophysics, 90 Astrophysics,* or *92 Solar Physics.*

No abstracts in this category.

# 71 ACOUSTICS

Includes sound generation, transmission and attenuation. For noise pollution see *45 Environmental Pollution.*

**N87-27479*#** Purdue Univ., West Lafayette, Ind. School of Mechanical Engineering.
**A STUDY OF METHODS TO PREDICT AND MEASURE THE TRANSMISSION OF SOUND THROUGH THE WALLS OF LIGHT AIRCRAFT Semiannual Status Report, 15 May - 15 Nov. 1986**
R. J. Bernhard, J. S. Bolton, B. Gardner, J. Mickol, C. Mollo, and C. Bruer Dec. 1986 27 p
(Grant NAG1-58)
(NASA-CR-180632; NAS 1.26:180632; HL-86-48; Rept-0353-5)
Avail: NTIS HC A03/MF A01 CSCL 20A

Several research investigations are discussed. The development of a numerical/empirical noise source identification procedure using boundary element techniques, the identification of structure-borne paths using structural intensity and finite element methods, the development of a design optimization numerical procedure to be used to study active noise control in three-dimensional geometries, and the measurement of the dynamic properties of acoustical foams and the incorporation of these properties in models governing three-dimensional wave propagation in foams are discussed. Author

**N87-27480*#** Georgia Inst. of Tech., Atlanta. School of Mechanical Engineering.
**SOUND PROPAGATION OVER UNEVEN GROUND AND IRREGULAR TOPOGRAPHY Semiannual Status Report, Aug. 1986 - Feb. 1987**
Yves H. Berthelot, James A. Kearns, Allan D. Pierce, and Geoffrey L. Main Feb. 1987 40 p
(Grant NAG1-566)
(NASA-CR-180644; NAS 1.26:180644; SASR-4) Avail: NTIS HC A03/MF A01 CSCL 20A

The goal of this research is to develop theoretical, computational, and experimental techniques for predicting the effects of irregular topography on long range sound propagation in the atmosphere. Irregular topography here is understood to imply a ground surface that is not idealizable as being perfectly flat or that is not idealizable as having a constant specific acoustic impedance. The interest of this study focuses on circumstances where the propagation is similar to what might be expected for noise from low-attitude air vehicles flying over suburban or rural terrain, such that rays from the source arrive at angles close to grazing incidence. The activities and developments that have resulted during the period, August 1986 through February 1987, are discussed. Author

**N87-27481#** Commissariat aux Energies Nouvelles, Algiers (Algeria). Centre d'Etudes Nucleaires et Solaires.
**GENERATION AND DETECTION OF ULTRASONIC WAVES M.S. Thesis**
D. Kalleche Jan. 1986 86 p In FRENCH
(DE87-701656; INIS-mf-10540) Avail: NTIS (US Sales Only) HC A05/MF A01

This work is not only to study and analyze the electromagnetic generation and detection of ultrasonic waves, but to investigate their possible application in nondestructive testing of materials as well. The theory was based upon the analysis of two magnetic effects. These are namely: the magnetostrictive effect and the electrodynamic effect. The analysis of the latter effect was founded upon a macroscopic and microscopic model. For each model, the propagation equation of the electromagnetically produced acoustic waves was established and resolved. In the microscopic model, two cases were considered: generation with static induction superposition and generation without static induction. As regards detection, only generation with static induction superposition was considered. Longitudinal and transverse waves were experimentally generated and detected in steel, aluminum, and copper. The following parameters were analyzed: the static induction effect; the nature of wave propagation in the medium; the effect of the distance between the generating coil, receiving coil, and the material surface; and the effect of the coil characteristics. Finally, the possibility of generating and detecting ultrasonic waves was analyzed using a single coil in a combined emission-reception mode. DOE

**N87-27482*#** Georgia Inst. of Tech., Atlanta. School of Mechanical Engineering.
**SOUND PROPAGATION OVER UNEVEN GROUND AND IRREGULAR TOPOGRAPHY Semiannual Status Report No. 5, Feb. - Jul. 1987**
Yves H. Berthelot, Allan D. Pierce, Ji-xun Zhou, Geoffrey L. Main, Pei-Tai Chen, James A. Kearns, and Nathaniel Chisholm Jul. 1987 9 p
(Grant NAG1-566)
(NASA-CR-181129; NAS 1.26:181129) Avail: NTIS HC A02/MF A01 CSCL 20A

The acoustic impedance of the surface coverings used in the laboratory experiments on sound diffraction by topographical ridges was determined. The model, which was developed, takes into account full wave effects and the possibility of surface waves and predicts the sound pressure level at the receiver location relative to what would be expected if the flat surface were not present. The sound pressure level can be regarded as a function of frequency, sound speed in air, heights of source and receiver, and horizontal distance from source to receiver, as well as the real and imaginary parts of the surface impedance. B.G.

**N87-27483** ESDU International Ltd., London (England).
**COMPUTER-BASED ESTIMATION PROCEDURE FOR SINGLE-STREAM JET-NOISE, INCLUDING FAR-FIELD, STATIC-JET MIXING NOISE DATABASE FOR CIRCULAR NOZZLES**
Aug. 1985 51 p
(ESDU-85018; ISBN-0-85679-524-0; ISSN-0307-0115) Avail: ESDU

ESDU 85018 provides a program listing for interpolating within or extrapolating a database. The data are normalized in terms of jet area, observer distance, and ambient pressure, and are then fitted in terms of jet velocity and temperature by a bipolynomial, either linear or quadratic. Values of the angle between the line to the observer and the jet axis must be multiples of ten degrees from 0 to 170 degrees. Appropriate weighting of the data is provided. The comprehensive database included is for a static jet with a circular nozzle and relates to mixing noise alone, but the user may provide an alternative database that can include other noise components (for example, combustion and shock noise) or may supplement the provided base with additional data. The use of the program is described and illustrated with a practical worked example. ESDU 85043 deals with coaxial jet noise. ESDU

**N87-27484*#** Duke Univ., Durham, N. C. Dept. of Mechanical Engineering and Materials Science.
**INTERIOR NOISE REDUCTION BY ALTERNATE RESONANCE TUNING Semiannual Progress Report**
Donald B. Bliss, James A. Gottwald, and Jeffrey W. Bryce Aug. 1987 39 p
(Grant NAG1-722)
(NASA-CR-181189; NAS 1.26:181189) Avail: NTIS HC A03/MF A01 CSCL 20A

Existing interior noise reduction techniques for aircraft fuselages perform reasonably well at higher frequencies, but are inadequate at low frequencies, particularly with respect to the low blade passage harmonics with high forcing levels found in propeller aircraft. A method is studied which considers aircraft fuselages lined with panels alternately tuned to frequencies above and below the frequency that must be attenuated. Adjacent panel would oscillate at equal amplitude, to give equal acoustic source strength, but with opposite phase. Provided these adjacent panels are acoustically compact, the resulting cancellation causes the interior acoustic modes to be cut off, and therefore be nonpropagating and evanescent. This interior noise reduction method, called Alternate Resonance Tuning (ART), is being investigated

theoretically and experimentally. Progress to date is discussed.
B.G.

**N87-27485*#** Purdue Univ., West Lafayette, Ind. School of Mechanical Engineering.
**A STUDY OF METHODS TO PREDICT AND MEASURE THE TRANSMISSION OF SOUND THROUGH THE WALLS OF LIGHT AIRCRAFT. NUMERICAL METHOD FOR ANALYZING THE OPTIMAL PERFORMANCE OF ACTIVE NOISE CONTROLLERS Thesis**
Christopher G. Mollo and Robert J. Bernhard Aug. 1987 242 p
(Grant NAG1-58)
(NASA-CR-181186; NAS 1.26:181186; Rept-0353-8; HL-87-25P)
Avail: NTIS HC A11/MF A01 CSCL 20A

An optimal active noise controller is formulated and analyzed for three different active noise control problems. The first problem formulated is the active control of enclosed or partially enclosed harmonic sound fields where the noise source strengths and enclosure boundary description are known. The enclosure boundary is described by either pressure, velocity, or impedance boundary conditions. The second problem formulated is the active control of the free field power radiated from a distributed noise source with a known time harmonic surface velocity. The third problem formulated is the active control of enclosed or partially enclosed harmonic sound field where the noise source strengths of enclosure boundary description may not be known. All three formulations are derived using an indirect boundary element technique. Formulation and verification of an indirect boundary element method is presented. The active noise controller formulations for enclosures are capable of analyzing systems with generalized enclosure shapes, point noise sources, and/or locally reacting impedance boundary conditions. For each formulation, representative results of optimal active noise controller case studies are presented, and some general conclusions are drawn. Author

**N87-27486#** Cincinnati Univ., Ohio. Dept. of Aerospace Engineering and Engineering Mechanics.
**INTERACTION OF ULTRASONIC WAVES WITH COMPOSITE PLATES Annual Report**
Adnan H. Nayfeh Apr. 1987 21 p
(Grant AF-AFOSR-0052-86)
(AD-A181169; AFOSR-87-0691TR) Avail: NTIS HC A02/MF A01 CSCL 11D

During the first year of our reporting period we continued our close cooperation with the NDE Branch of the Materials Lab at Wright-Patterson Air Force Base. For our research part, we continued supplying analytical and computational methods on the modeling of the mechanical behavior of fibrous composites for applications in the non-destructive evaluation (NDE) field. Specifically, we developed theoretical models to describe the influence of fibrous composite's microstructure (both in the forms of dispersive and anisotropic effects) and its gross behaviors. This was verified experimentally by using Leaky Wave propagation techniques whereas the scientific group at Wright Patterson continued conducting experimental verification of our modeling.
GRA

**N87-27487#** Yale Univ., New Haven, Conn. Dept. of Computer Science.
**AN EFFICIENT METHOD FOR SOLVING THE THREE-DIMENSIONAL WIDE ANGLE WAVE EQUATION**
Ding Lee, Youcef Saad, and Martin H. Schultz Oct. 1986 17 p
(Contract N00014-82-K-0184)
(AD-A181248; YALEU/DCS/RR-463) Avail: NTIS HC A02/MF A01 CSCL 20A

The authors propose a new method for the solution of the wide angle wave equation in three dimensions. In contrast with standard techniques, our approach requires only solutions of successive tridiagonal systems in the resulting finite difference parabolic equations. The method is based on a simple approximation to the square-root operator written formally as the square root of $1+x+y$ where x is a partial differential operator with respect to the depth z and Y is a partial differential operator with respect to the azimuthal angle theta. This documents the fact that the partial derivative term y with respect to the azimuthal angle is small, but not negligible, as compared with other terms. It is then natural to replace the square-root operator by an expansion which is of order 2 with respect to the X operator, and of order 1 with respect to the Y operator. An important feature of this approach is that it is then possible to derive a rational function approximation to the exponential of the square-root operator which has the property of being stable, and accurate. Moreover, the approximation decouples naturally as a product of a (1,1) rational function of y. As a consequence, this will result in a solution technique that requires only two tridiagonal system solutions per step, namely one for the X operator and one for the Y operator. Numerical examples are reported that show the wide angle capability of this method.
GRA

**N87-27488#** Stanford Univ., Calif.
**NONLINEAR AND RANDOM PHENOMENA IN ELECTROMAGNETIC AND ACOUSTIC WAVE PROPAGATION Final Report, 15 Jan. 1985 -14 Jan. 1987**
Joseph B. Keller Mar. 1987 5 p
(Contract DAAG29-85-K-0024)
(AD-A181649; ARO-21068.18-MA) Avail: NTIS HC A02/MF A01 CSCL 20K

The acoustoelastic effect is the dependence of sound speed upon stress in an elastic solid due to nonlinearity. This effect can be used for nondestructive testing of structural components of aircraft, vehicles, etc. A theory of the effect was developed which involved analyzing acoustic wave propagation in random anisotropic solids. A related theory of the effective elastic constants of solids composed of aggregates of polycrystals was also developed. For anisotropic composite materials reciprocal relations satisfied by their effective thermal or electrical conductivity tensors were discovered. In the case of scalar materials such relations have been very useful, so the new ones may be useful too. It has also been shown how the elastic properties of the ground could be determined from seismic scattering data. This method used the Born approximation, and led to results involving Fourier transforms.
GRA

**N87-27489*#** Old Dominion Univ., Norfolk, Va. Research Foundation.
**INFLUENCE OF LARGE DEFLECTION AND TRANSVERSE SHEAR ON RANDOM RESPONSE OF RECTANGULAR SYMMETRIC COMPOSITE LAMINATES TO ACOUSTIC LOADS**
Chuh Mei and C. B. Prasad Jun. 1987 71 p
(Contract NAS1-17993)
(NASA-CR-178313; NAS 1.26:178313) Avail: NTIS HC A04/MF A01 CSCL 20A

Nonlinear equations of motion of symmetrically laminated anisotropic plates are derived accounting for von Karman strains. The effect of transverse shear is included in the formulation and the rotatory inertia effect is ignored. Using a single-mode Galerkin procedure the nonlinear modal equation is obtained. Direct equivalent linearization is employed. The response of acoustic excitation on moderately thick composite panels is studied. Further, the effects of transverse shear on large deflection vibration of laminates under random excitation are studied. Mean-square deflection and mean-square inplane stresses are obtained for some symmetric graphite-epoxy laminates. Using equilibrium equations and the continuity requirements, the mean-square transverse shear stresses are calculated. The results obtained will be useful in the sonic fatigue design of composite aircraft panels. The analysis is presented in detail for simply supported plate. The analogous equations for a clamped case are given in the appendix. Author

**N87-27490*#** Utah Univ., Salt Lake City. Dept. of Mechanical and Industrial Engineering.
**ACOUSTIC PROPAGATION IN A THERMALLY STRATIFIED ATMOSPHERE Final Report**
W. K. VanMoorhem Sep. 1987 114 p
(Grant NAG1-283)
(NASA-CR-181235; NAS 1.26:181235; UTEC-ME-87-034) Avail: NTIS HC A06/MF A01 CSCL 20A

(NASA-CR-181235; NAS 1.26:181235; UTEC-ME-87-034) Avail: NTIS HC A06/MF A01 CSCL 20A

Acoustic propagation in an atmosphere with a specific form of temperature profile has been investigated by analytical means. The temperature profile used is representative of an actual atmospheric profile and contains three free parameters. Both lapse and inversion cases have been considered. Although ray solution have been considered the primary emphasis has been on solutions of the acoustic wave equation with point force where the sound speed varies with height above the ground corresponding to the assumed temperature profile. The method used to obtain the solution of the wave equation is based on Hankel transformation of the wave equation, approximate solution of the transformed equation for wavelength small compared to the scale of the temperature (or sound speed) profile, and approximate or numerical inversion of the Hankel transformed solution. The solution displays the characteristics found in experimental data but extensive comparison between the models and experimental data has not been carried out. Author

**N87-27491#** Aeronautical Research Inst. of Sweden, Stockholm. Aerodynamics Dept.

**A STUDY OF ENVIRONMENTAL NOISE WITH A VIEW TO AIRCRAFT WITH PROP-FANS**

Sten Ljunggren Feb. 1987 12 p Sponsored by the Swedish National Board for Technical Development

(FFA-TN-1987-15; ETN-87-90075) Avail: NTIS HC A02/MF A01

Swedish legislation concerning noise from prop-fan aircraft in cruising flight is discussed. A limit of 55 dB(A) is recommended if night flights increase considerably, 60 dB(A) being acceptable for other conditions. ESA

**N87-27248*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, Va.

**NASTRAN APPLICATION FOR THE PREDICTION OF AIRCRAFT INTERIOR NOISE**

Francesco Marulo and Todd B. Beyer *In* COSMIC, 15th NASTRAN Users' Colloquium Aug. 1987 p 266-285 (For primary document see N87-27231 21-39)

Avail: NTIS HC A14/MF A01; also available from COSMIC, Athens, Ga. 30602 CSCL 20K

# 72 ATOMIC AND MOLECULAR PHYSICS

Includes atomic structure, electron properties, and molecular spectra.

**N87-27492#** Stanford Univ., Calif.

**GAS-SURFACE REACTIONS Final Report, 1 Mar. 1984 - 28 Feb. 1987**

Richard N. Zare 15 Apr. 1987 9 p

(Contract DAAG29-84-K-0027)

(AD-A180625; ARO-21052.8-CH) Avail: NTIS HC A02/MF A01 CSCL 07D

Studies were conducted on the fundamental gas-surface scattering processes. Significant advances were made in understanding inelastic scattering processes when a diatomic molecule strikes a well-defined single-crystal surface in an ultra high vacuum environment or when atoms permeate through a metal and recombinatively desorb. GRA

**N87-27493#** Naval Research Lab., Washington, D.C.

**CALCULATION OF PHASE SHIFTS IN SCATTERING THEORY Final Report, Jun. 1986 - Feb. 1987**

A. Batra, G. D. Drew, and D. A. Papaconstantopoulos 26 Apr. 1987 169 p

(AD-A180640; NRL-MR-5944) Avail: NTIS HC A08/MF A01 CSCL 20J

Quantum mechanical calculations are presented for the scattering phase shifts of 53 elements in the periodic table. The results of these calculations are presented both as table and as graphs. GRA

**N87-27494#** Stockholm Univ. (Sweden). Inst. of Physics.

**MASSES FOR CLANS INTRODUCED TO EXPLAIN HADRONIC MULTIPLICITY DISTRIBUTIONS**

C. Fuglesang Jan. 1987 20 p

(USIP-87-01; ETN-87-90080) Avail: NTIS HC A02/MF A01

The fact that the negative binomial distribution very well describes high energy multiplicity distributions and that this distribution is the result of a compound Poisson-logarithmic distribution is used to search for dynamics in particle production. It is shown that the logarithmic distribution for the particle multiplicity of clans (superclusters) follows if the number of particles in the clans follows a Poisson distribution at fixed mass and the mass distribution belongs to a certain class distributions. Data are used to set limits on possible mass distributions. ESA

# 73 NUCLEAR AND HIGH-ENERGY PHYSICS

Includes elementary and nuclear particles; and reactor theory.

For space radiation see *93 Space Radiation.*

**N87-27495*#** Oregon State Univ., Corvallis. Dept. of Nuclear Engineering.

**AN ASSESSMENT AND VALIDATION STUDY OF NUCLEAR REACTORS FOR LOW POWER SPACE APPLICATIONS Final Report 1986, 1 Nov. - 30 Apr. 1987**

A. C. Klein, S. R. Gedeon, and D. C. Morey 26 Jun. 1987 53 p

(Grant NAG3-752)

(NASA-CR-180672; NAS 1.26:180672; OSU-NE-8702) Avail: NTIS HC A04/MF A01 CSCL 18N

The feasibility and safety of six conceptual small, low power nuclear reactor designs was evaluated. Feasibility evaluations included the determination of sufficient reactivity margins for seven years of full power operation and safe shutdown as well as handling during pre-launch assembly phases. Safety evaluations were concerned with the potential for maintaining subcritical conditions in the event of launch or transportation accidents. These included water immersion accident scenarios both with and without water flooding the core. Results show that most of the concepts can potentially meet the feasibility and safety requirements; however, due to the preliminary nature of the designs considered, more detailed designs will be necessary to enable these concepts to fully meet the safety requirements. Author

**N87-27496#** Lawrence Livermore National Lab., Calif.

**RECENT MEASUREMENTS OF COHERENT TRANSITION RADIATION**

M. J. Moran 25 Sep. 1986 14 p Presented at the 9th International Conference on Application of Accelerators in Research and Industry, Denton, Tex., 10 Nov. 1986

(Contract W-7405-eng-48)

(DE87-009945; UCRL-94811-Rev-1; CONF-861114-55-Rev-1)

Avail: NTIS HC A02/MF A01

An extended series of experiments has been used to investigate transition radiation in the X-ray spectral region. The X-rays were generated at the Lawrence Livermore National Laboratory electron-positron linear accelerator by 54 MeV electrons traversing multiple thin-foil targets. The measured angular and spectral distributions have shown excellent agreement with calculated predictions based on a simplified theoretical description of transition radiation. Recently, energy-resolved measurements of X-ray generation by targets consisting of multiple closely-spaced foils has clearly demonstrated the longitudinal coherence of transition radiation. This behavior might lead to a variety of applications such as tunable narrow-band X-ray sources, measurement of X-ray dielectric constants, or particle beam diagnostics. These issues will be discussed, and recent results will be presented. DOE

**N87-27497#** Lawrence Livermore National Lab., Calif.
**CHARACTERISTICS OF TRANSITION RADIATION IN THE X-RAY SPECTRAL REGION**
M. J. Moran Jun. 1986 9 p Presented at the 30th SPIE Technical Symposium on Optics and Optoelectronic Engineering, San Diego, Calif., 17 Aug. 1986
(Contract W-7405-eng-48)
(DE87-009946; UCRL-94730; CONF-860880-53) Avail: NTIS HC A02

Measurements of soft X-ray production by transition radiation have been performed in a series of experiments at the Lawrence Livermore National Laboratory. The results have shown that transition radiation is an intense and predictable source of photons in the soft X-ray energy range. This paper will give a brief review of the general properties of the X-ray distributions generated by these sources. DOE

**N87-27498#** RAND Corp., Santa Monica, Calif.
**SOVIET RESEARCH ON THE TRANSPORT OF INTENSE RELATIVISTIC ELECTRON BEAMS THROUGH HIGH-PRESSURE AIR**
Nikita Wells May 1987 86 p
(Contract MDA903-85-C-0030)
(R-3463-DARPA; LC-86-31496; ISBN-0-8330-0787-4) Avail: NTIS HC A05/MF A01

Soviet development of intense relativistic electron beams (IREB) through background air at pressures from 1/100 Torr to atmospheric is analyzed as reflected by Soviet open literature of the last 15 years. Important Soviet findings include: (1) the formation of a plasma channel created by an IREB propagating through background air and the effect of beam parameters upon the plasma channel parameters (and vice versa); (2) determination of the background air pressure for the optimum transport of IREB in two ranges, an ion focused regime at 0.06 to 0.09 Torr and a low pressure window at 1 Torr; (3) observation of current enhancement, whereby the IREB-induced current in plasma is higher than the initial beam current; and (4) the effect of resistive hose instability on IREB propagation. This research is characterized by absence of high energy experimentation. A conclusion of the research is that, for optimum beam transport through air, it is imperative to ensure conditions that allow full neutralization of the IREB's self-fields along the entire path of the beam's transport. J.P.B.

# 74 OPTICS

Includes light phenomena; and optical devices.
For lasers see *36 Lasers and Masers*.

**N87-27499*#** Alabama Univ., Huntsville. Dept. of Electrical Engineering.
**THE FEASIBILITY AND DESIGN OF OPTICAL SENSORS FOR MODAL CONTROL Final Report, 1 Sep. 1986 - 31 May 1987**
Charles A. Lundquist 17 Jul. 1987 34 p
(Grant NAG8-587)
(NASA-CR-181184; NAS 1.26:181184) Avail: NTIS HC A03/MF A01 CSCL 20F

The feasibility of optical type sensors for control of flexible bodies was examined. The accuracies of such systems were determined via simulation and the sources of potential errors were designated. An initial laboratory design was effected and preliminary results obtained. These results are discussed critically with applications to future studies and system designs. B.G.

**N87-27500#** Rochester Univ., N. Y. Inst. of Optics.
**OPTICAL SYSTEMS AND STATISTICAL OPTICS Final Technical Report, 24 Oct. 1983 - 31 Jan. 1985**
Nicholas George 24 Apr. 1987 65 p
(Grant AF-AFOSR-0018-84)
(AD-A180825; AFOSR-87-0599TR) Avail: NTIS HC A04/MF A01 CSCL 20F

A novel optical transform system has been conceived and demonstrated. It consists of a twin imaging interferometer followed by an all glass Fourier achromat, a CCD array, and an electronic digital computer. This final report has brief descriptions of publications made on this topic during the contract period with the papers appended for easy reference. A comprehensive study has also been made of the performance of holographic optical elements. It has been found that general operating features of complicated elements are most easily explained quantitatively by a phased scatter analysis. However, precise quantitative performance is best analyzed using a modified form of thin grating decomposition. GRA

**N87-27501#** Naval Research Lab., Washington, D.C.
**DETECTING A TARGET OF UNKNOWN BRIGHTNESS IN CLUTTER Interim Report, Jan. - Sep. 1986**
Charles F. Osgood and Richard G. Priest 27 Apr. 1987 12 p
(AD-A180925; NRL-9045) Avail: NTIS HC A02/MF A01 CSCL 17E

Standard infrared target detection algorithms based on the Bayes decision rule or Neyman-Pearson test are optimal only when testing for targets of known strength (brightness). The discriminant functions used in these tests depend, in functional form, on the assumed brightness of the targets being sought. That is to say, they are not uniform with respect to target brightness. Linear uniform tests such as the matched filter are not near optimal for multidimensional cases. The case of interest here is a multidimensional one-the detection of moving targets in differenced mosaic images. The uniform tests that we consider are the generalized maximum likelihood (GML) tests. Three implementations are discussed. Results are presented that indicate that the uniform GML test compares favorably with the optimal Bayes decision rule for detection of moving targets in mosaic imagery. GRA

**N87-27502#** Cornell Univ., New York, N.Y. School of Applied and Engineering Physics.
**WAVELENGTH INDEPENDENT OPTICAL MICROSCOPY AND LITHOGRAPHY Annual Progress Report, Sep. 1984 - Sep. 1986**
M. Isaacson and A. Lewis 29 Apr. 1987 31 p
(Grant AF-AFOSR-0314-84)
(AD-A181017; AFOSR-87-0742TR) Avail: NTIS HC A03/MF A01 CSCL 14E

In summary, our experiments thus far have demonstrated the feasibility of the subwavelength optical technology we have pioneered under this contract. Thus, these experiments confirm the exciting potential for applications of the near-field technology in a variety of areas of interest to the Air Force. GRA

**N87-27503#** TRW, Inc., Redondo Beach, Calif. Electro Optics Research Center.
**PLANAR MULTIMODE FIBER OPTIC COUPLERS Final Technical Report, Jul. 1984 - Apr. 1986**
Charles Asawa and Talal Findakly Feb. 1987 70 p
(Contract F19628-84-C-0123)
(AD-A181131; RADC-TR-86-225) Avail: NTIS HC A04/MF A01 CSCL 20F

This report presents the results of our 1.75 years investigation of the fabrication of multimode star and access couplers in glass using the thallium-sodium ion exchange method. Four-port access and eight port transmission star couplers were fabricated on BK-7 glass. Electric-field-assisted thermal ion exchange was used to fabricate couplers. The photolithographic masks were designed with varying waveguide widths and mixing lengths. The best mask material was found to be silicon dioxide of 5000 angstroms thickness. Measurements were performed on efficiencies and distribution uniformities on both the single diffusion samples. Excellent first diffusion couplers were fabricated. Less than 0.2 dB and 1.0 dB non-uniformity in the splitting ratios were measured for the best first diffusion 2x2 and 4x4 couplers, respectively. Experiments were performed to bury the couplers below the surface of the glass with a second electric-field assisted diffusion for the purpose of reducing optical loss at the surface. Partially buried

waveguides were formed but these waveguides exhibited greater scattering than the first diffusion waveguides. Author (GRA)

**N87-27504#** Environmental Research Inst. of Michigan, Ann Arbor.
**OPTICAL SWITCHING BY STIMULATED THERMAL RAYLEIGH SCATTERING Semiannual Report, 15 Jun. 1984 - 15 Feb. 1985**
Lauren M. Peterson Jun. 1986 33 p
(Contract F49620-84-C-0067; DARPA Order 4592)
(AD-A181181; ERIM-1759008-T; AFOSR-87-0693TR) Avail: NTIS HC A03/MF A01 CSCL 20F

Preliminary experiments were conducted whose ultimate goal is to develop all-optical control functions useful in an all-optical or optical-electronic hybrid digital computer or for optical interconnects. Stimulated thermal Rayleigh scattering (STRS) based upon generator experiments was pursued for scattering angles of 90 deg and 180 deg (backscattering). A pulsed nitrogen laser pumped dye laser served as the radiation source and the interaction medium was a liquid to which an absorbing dye was added. STRS amplifier experiments were successful and gain was observed and studied parametrically using eosine dye in ethanol. The gain was found to increase (although the gain coefficient decreased) with increasing pump power and the gain was found to be a maximum at an absorption coefficient of about 2.6 per cm. The generator experiments did not lead to stimulated scattering due to the limited output power of the laser and its multi-longitudinal spectral mode content. These studies will be continued along with analytical modeling in order to characterize the interaction and to enable the optimization of the scattering process. GRA

**N87-27505#** Quantex Corp., Rockville, Md.
**NEW MATERIALS FOR OPTICAL COMPUTATIONS. PHASE 1: FEASIBILITY STUDY Final Report**
Joseph Lindmayer 1986 27 p
(Contract N00014-86-C-0807)
(AD-A181566; SDIO-86-11) Avail: NTIS HC A03/MF A01 CSCL 09E

High speed data processing by optical means is needed. Progress in optical memories and logic is determined by the availability of new photonic materials. The Phase 1 feasibility study concentrated on the use of certain II-VI compounds that display unusual optical properties, offering new opportunities of the realization of erasable optical memories, processors and computers. The feasibility of the erasable memory function is well documented. Optical processors and logic functions were also examined and the results to date show that, with application of larger resources, logic functions can be developed. Much progress has been made in the erasable optical memory area. Clearly, information can be written by a visible light source, which is then retained in the form of the spatial distribution of trapped electrons. It has been demonstrated that both digital and analog information can be stored this way. Reading is accomplished by a gentle infrared beam that partially discharges the traps in the process of reconstructing the information. While each reading reduces the trapped electron density, many readings can be made and the information easily written. GRA

**N87-27506#** Texas Technological Univ., Lubbock. Dept. of Electrical Engineering.
**SPACE-VARIANT OPTICAL SYSTEMS Interim Report, 30 Nov. 1985 - 30 Sep. 1986**
John F. Walkup and Thomas F. Krile 30 Mar. 1987 17 p
(Grant AF-AFOSR-0382-84)
(AD-A181700; AFOSR-87-0614TR) Avail: NTIS HC A02/MF A01 CSCL 09F

Analytical and experimental investigations of 1-D and 2-D coherent and incoherent space-variant optical processors have been conducted. Areas investigated have included: (1) bilinear transform implementations using AO processors; (2) optical polynomial processing; (3) window-programmable image processors; (4) optical multistage interconnection networks; and (5) a 2-D C1os interconnection network. GRA

**N87-27507#** Honeywell, Inc., Bloomington, Minn. Physical Sciences Center.
**OPTICAL SYMBOLIC PROCESSOR FOR EXPERT SYSTEM EXECUTION Quarterly Technical Report, 1 Dec. 1986 - 28 Feb. 1987**
Matthew Derstine, Aloke Guha, and Subra Natarajan 23 Apr. 1987 53 p
(Contract F49620-86-C-0082; ARPA Order 5794; DA Proj. 2305)
(AD-A181833; AFOSR-87-0690TR) Avail: NTIS HC A04/MF A01 CSCL 20F

In recent years there has been a great deal of interest in combining the extraordinary communications power of optics with symbolic computing techniques to develop a highly parallel optical computer. Advances in parallel computer architecture and development of digital optical components and systems have laid the groundwork for such a computer. In this report we describe the development of an optical architecture designed for symbolic computing. In previous work we examined logic and functional languages to determine which had characteristics more amenable to optical implementation. We found (cf. 2nd Tech. Report) that functional languages were a better fit than others and that combinator graph reduction (CGR) was the appropriate computational model. We also examined symbolic substitution and other optical computing techniques to determine which could provide the most power and flexibility. We decided that symbolic substitution coupled with some form of data movement scheme was the best scheme to employ. GRA

**N87-27508#** Aerodyne Products Corp., Billerica, Mass.
**OPTICAL CARRY ADDER Final Report, Aug. 1985 - Nov. 1986**
J. B. McManus and R. S. Putnam Mar. 1987 65 p
(Contract F30602-84-C-0130)
(AD-A181856; ARI-RR-555; RADC-TR-87-11) Avail: NTIS HC A04/MF A01 CSCL 20F

We have constructed a hybrid electronic/electro-optic digital adder which uses an optical-carry for fully parallel operation. It adds two four-bit words at a data rate of 10 MHz. Electronic logic is used for summing the addend and carry bits, while the carries are generated optically. Ideally, this system reduces the number of gate delays associated with electronic addition of long addends, and has an execution time that does not increase with longer addends. The optical-carry (B. Arazi, Proc. IEEE 73, 162, 1/85) is based upon a multi-stage optical path, with sources which add light to the path if a carry is generated, and with modulators which allow light to pass if a carry is propagated, at the corresponding column of the addition. The signals which set the light sources and modulators are derived from the addends simultaneously, so the addition is completed as soon as detected light signals reach the summing logic. With small changes in the driving logic, the device operates as a parallel subtractor, with optical borrow propagation. Our breadboard system has six acousto-optic modulators (AOM's) as optical switches, with a single HeNe laser source. Author (GRA)

**N87-27509*#** National Aeronautics and Space Administration, Washington, D.C.
**ORGANIC NONLINEAR OPTICAL MATERIALS**
S. Umegaki Jul. 1987 15 p Transl. into ENGLISH from Yuuki Hisenkei Koogaku Zairyoo, Oyo Butsuri (Japan), v. 54, no. 2, 1985 p 137-142 Transl. by Kanner (Leo) Associates, Redwood City, Calif.
(Contract NASw-4006)
(NASA-TT-20029; NAS 1.77:20029) Avail: NTIS HC A02/MF A01 CSCL 20F

Recently, it became clear that organic compounds with delocalized pi electrons show a great nonlinear optical response. Especially, secondary nonlinear optical constants of more than 2 digits were often seen in the molecular level compared to the existing inorganic crystals such as LiNbO3. The crystallization was continuously tried. Organic nonlinear optical crystals have a new future as materials for use in the applied physics such as photomodulation, optical frequency transformation, opto-bistabilization, and phase conjugation optics. Organic nonlinear optical

materials, e.g., urea, O2NC6H4NH2, I, II, are reviewed with 50 references. B.G.

**N87-27510#** Oesterreichisches Forschungszentrum Seibersdorf G.m.b.H., Vienna. Dept. of Materials Technology.
**HIGHLY EFFICIENT DETECTOR SYSTEMS FOR CATHODOLUMINESCENCE SCANNING ELECTRON MICROSCOPE (CL SEM) FOR THE FAR INFRARED AND VACUUM ULTRAVIOLET SPECTRAL RANGES**
Erwin M. Hoerl, Reinhard Dittler, Peter Scholze, and Egon Preissner Oct. 1986 8 p Presented at the 11th International Congress on Electron Microscopy, Kyoto, Japan, 31 Aug. - 7 Sep. 1986
(OEFZS-4375; WE-409/86; ETN-87-90065) Copyright Avail: NTIS HC A02/MF A01

For the far infrared region, a detector consisting of two ellipsoidal mirrors for focusing the light and a germanium bolometer as detection element for electron microscopy was developed. The system for the vacuum ultraviolet is such that the specimen is located in ultrahigh vacuum in order to obtain an atomically clean surface. For the detection of the radiation an open photomultiplier or multiplier with a quartz window coated with soldium salicilate is used. ESA

**N87-27511#** Research Inst. of National Defence, Linkoeping (Sweden). Dept. 3.
**[ACTIVITIES REPORT OF THE DIVISION OF OPTICAL TECHNOLOGY] Annual Report, 1985**
Erik Daniels Jan. 1987 21 p
(FOA-C-30436-3; ISSN-0347-3708; ETN-87-90070) Avail: NTIS HC A02/MF A01; Research Institute of National Defence, Stockholm KR 50

Research concerning hydrooptics; coherent CO2 laser radar; remote sensing with lasers; optical signatures; atmospheric transmission; fiber optics; optical processing; simulation in terrain models; and ionizing radiation effects on electronics is summarized. ESA

# 75 PLASMA PHYSICS

Includes magnetohydrodynamics and plasma fusion.

For ionospheric plasmas see *46 Geophysics*. For space plasmas see *90 Astrophysics*.

**N87-27512#** Columbia Univ., New York. Plasma Physics Lab.
**IDEAL, STEADY-STATE, AXISYMMETRIC MAGNETOHYDRODYNAMIC EQUATIONS WITH FLOW Ph.D. Thesis**
Yurij Andrew Baransky 1987 193 p
(Contract DE-FG02-86ER-53222)
(DE87-010237; DOE/ER-53222/93) Avail: NTIS HC A09/MF A01

The effect of rotation on the equilibrium of a plasma is studied. The axisymmetric equilibria of ideal magnetohydrodynamics (MHD) with flow have been studied numerically and analytically. A general discussion is provided of previous work on plasmas with flow and comparisons are made to the static model. A variational principle has been derived for the two dimensional problem with comments as to appropriate boundary conditions. An inverse aspect ratio expansion has been used for a study of the toroidal flow equation for both low- and high-Beta. The inverse aspect ratio expansion has also been used for a study of equations with both poloidal and toroidal flow. An overview is provided of the adaptive finite-difference code which was developed to solve the full equations. DOE

**N87-27513#** Maryland Univ., College Park. Lab. for Plasma and Fusion Energy Studies.
**SPACE CHARGE LIMITED AND TEMPERATURE LIMITED ELECTRON FLOW IN THE VICINITY OF EDGES AND CONICAL POINTS Interim Report, Jan. 1986 - Jan. 1987**
J. M. Finn, T. M. Antonsen, Jr., and W. M. Manheimer (Naval Research Lab., Washington, D.C.) 4 May 1987 47 p Sponsored by ONR, Washington, D.C.
(AD-A180997; NLR-MR-5945) Avail: NTIS HC A03/MF A01 CSCL 20C

Similarity solutions for electron flow in the neighborhood of edges (cylindrical corners) and points are found. Boundary conditions on the cathode giving space limited and temperature limited flow are used. The results show the scaling of density, potential and current density with distance from the singularity as a function of corner angle (cone angle). The results are expected to be useful in initializing trajectories in simulation codes for various designs involving sharp corners and points. GRA

**N87-27514#** California Univ., Berkeley.
**LASER SPECTROSCOPY OF PLASMAS Annual Report, Dec. 1985 - Dec. 1986**
John W. Daily 15 Mar. 1987 22 p
(Grant AF-AFOSR-0067-86)
(AD-A181007; AFOSR-87-0744TR) Avail: NTIS HC A02/MF A01 CSCL 20I

During the past year, work was initiated to develop novel advanced laser spectroscopy plasma diagnostic methods. The methods are based on observing the Doppler shift in the absorption lines of ionic species. Two methods under study are Velocity Modulated Laser Spectroscopy and Two-Beam Doppler Shift Laser Spectroscopy. The scientific goal of the work is to increase understanding of plasmas by making in-situ measurements of ion mobilities, concentrations and temperatures in a non-intrusive fashion. The scientific approach is to combine conventional laser spectroscopies with velocity detection. Using a method such as Rayleigh fluorescence, or Raman scattering, one probes the Doppler profile of the specie of interest, observing shifts in the Doppler profile that arises because of the presence of an electric field. The shift may be related to the ion mobility, and thus conductivity, if the electric field is known, or to the electric field if the mobility is known. Temperature and concentration may be recovered by the conventional means. GRA

**N87-27515#** Naval Research Lab., Washington, D.C.
**LASER-PRODUCED PLASMAS AND HYPERVELOCITY ACCELERATION**
Barrett H. Ripin 15 May 1987 11 p
(AD-A181285; NRL-MR-5837) Avail: NTIS HC A02/MF A01 CSCL 20I

Laser produced plasmas have properties that overlap those of armatures required for hypervelocity particle acceleration. This makes them useful as a test bed for advanced acceleration schemes and effects. In addition, sophisticated diagnostics have been developed for measuring laser produced plasma conditions; many of these techniques can be applied or adapted to KEW armature problems. GRA

**N87-27516#** Maryland Univ., College Park. Dept. of Electrical Engineering.
**LASER INDUCED SOLID STATE PLASMA FOR MILLIMETER-WAVE DEVICE APPLICATIONS Final Report, 1 May 1983 - 30 Dec. 1986**
Chi H. Lee 31 Mar. 1987 74 p
(Contract DAAG29-83-K-0079)
(AD-A181298; ARO-20100.7-EL) Avail: NTIS HC A04/MF A01 CSCL 09A

The optical technique offers unique advantages in: (1) near perfect isolation between controlling and controlled devices, (2) elimination of RF feeds in a large array system, (3) immunity from electromagnetic interference, (4) light weight and compact size, (5) extremely fast response, (6) high power handling capability, and (7) amendability to monolithic integration. The results are summary of the investigation of a number of millimeter wave device concepts based on laser induced solid state plasma in semiconductors. The generation and control of millimeter wave and microwaves by optoelectronic techniques are reported. Complete time synchronization between Radiofrequency and optical

signals is achieved. Laser controlled phase shifters, switches and modulators at 94 GHz are described. GRA

**N87-27517#** Wisconsin Univ., Madison. Dept. of Electrical and Computer Engineering.
**A PLASMA-OPTICAL SYSTEM MODELED USING PARTICLES**
W. N. G. Hitchon Feb. 1987 19 p
(DE87-008395; DOE/ER-53201/T2) Avail: NTIS HC A02/MF A01

A particle model of plasma behavior suitable for application to the study of plasma-optical systems has been developed. A plasma-optical system which removes macroscopic droplets from a neutralized beam of ions and electrons, produced by an arc, has been modeled and its performance has been analyzed. The particle model employs an extremely efficient treatment of the electron motion through a background gas, which in this case consists of neutral particles. The distribution of distances traveled by electrons in the course of many collisions with the neutral background is generated using a Monte Carlo method and is sampled from to determine the electron motion at each integration step. In sheath regions, for instance, direct integration is still necessary, but for most electrons the simulation is very fast, largely removing the numerical stiffness of the particle method. This method will be equally effective for time-dependent fields such as occur in RF discharges used in plasma processing. The variation is ion current to a substrate, where the ions deposit as a thin film has been studied. The objective is to maximize the deposition rate while preventing macroscopic particles which arise at the arc from striking the film. An alternative system whose calculated transmittal rate from source to target is higher, for long mean-free-paths, is also examined. DOE

**N87-27518#** Sandia National Labs., Albuquerque, N. Mex.
**ANALYTIC THEORY OF THE RAYLEIGH-TAYLOR INSTABILITY IN A UNIFORM DENSITY PLASMA-FILLED ION DIODE**
T. W. Hussey and S. S. Payne Apr. 1987 23 p
(Contract DE-AC04-76DP-00789)
(DE87-009535; SAND-87-1120) Avail: NTIS HC A02/MF A01

The J-vector x B-vector forces associated with the surface current of a plasma-filled ion diode will accelerate this plasma fill toward the anode surface. It is well known that such a configuration with a high I is susceptible to the hydromagnetic Rayleigh-Taylor instability in certain geometries. A number of ion diode plasma sources have been proposed, most of which have a falling density going away from the wall. A somewhat more unstable case, however, is that of uniform density. In this report we attempt to establish an upper limit on this effect with a simple analytic model in which a uniform-density plasma is accelerated by the magnetic field anticipated in a PBFA-II diode. The number of linear e-foldings experienced by an unstable surface is estimated as well as the most damaging wavelength initial perturbation. This model, which accounts approximately for stabilization due to field diffusion, suggests that even with a uniform fill, densities in excess of a few 10 to the 15th power are probably not damaged by the instability. In addition, even lower densities might be tolerated if perturbations near the most damaging wavelength can be kept very small. DOE

**N87-27519#** Office National d'Etudes et de Recherches Aerospatiales, Paris (France). Direction de la Physique Generale.
**STUDY OF A NITRIDING PLASMA USING COHERENT ANTI-STOKES RAMAN SPECTROSCOPY Final Report [ETUDE PAR DRASC DUN PLASMA DE NITRURATION]**
M. Pealat and M. Lefebvre Jan. 1987 29 p In FRENCH
(Contract DRET-85-34-001)
(ONERA-RS-4/3644-PY-150-P; ETN-87-90121) Avail: NTIS HC A03/MF A01

The rotational and vibrational distribution of the first levels of excitation of N2 molecular system were measured using Raman diffusion in the discharge of a nitriding plasma. The nitrided specimens were analyzed using metallography and X-ray diffraction. ESA

# 76 SOLID-STATE PHYSICS

Includes superconductivity.

For related information, see also *33 Electronics and Electrical Engineering* and *36 Lasers and Masers.*

**N87-27520*#** Illinois Univ., Urbana. Dept. of Electrical and Computer Engineering.
**SEMICONDUCTOR SUPERLATTICE PHOTODETECTORS Semiannual Report, 1 Jul. - 31 Dec. 1985**
S. L. Chuang, K. Hess, J. J. Coleman, and J. P. Leburton 16 Jan. 1986 41 p
(Grant NAG1-500)
(NASA-CR-180300; NAS 1.26:180300) Avail: NTIS HC A03/MF A01 CSCL 20L

Technical progress made in the study of superlattice photoconductors is summarized and papers submitted for publication are listed. Since the quantum-well regions may contain several subbands, each of which may be occupied by electrons depending on the doping concentrations, it is important to include the multi-subbands in calculating the impact ionization rate. The electrons occupying the higher subbands require a smaller amount of energy to get out of the quantum well; thus, those higher level subband electrons contribute significantly to the impact ionization rate. The results of the subbands have been calculated. Results concerning the nonparabolicity effect of the band structure, the effect of the quantum-well size, and the effect of the band-edge discontinuity and doping are also summarized. M.G.

**N87-27521*#** Longwood Coll., Farmville, Va.
**THE EFFECT OF ASPECT RATIO AND FLUID FLOW ON CRYSTAL GROWTH Semiannual Report**
Patrick G. Barber 31 Dec. 1986 11 p
(Grant NAG1-627)
(NASA-CR-180343; NAS 1.26:180343; SAR-2) Avail: NTIS HC A02/MF A01 CSCL 20B

Supersaturated solutions were conditioned at different aspect ratios before crystal growth. The conditioned solutions were poured out into a dish to initiate crystal nucleation and growth. The rate of growth was measured microscopically and found to depend upon the aspect ratio. Secondly, the number and size of crystals formed was found to depend upon the aspect ratio. The data support the above conclusion, but do not prove it. Author

**N87-27522*#** Illinois Univ., Urbana. Dept. of Electrical and Computer Engineering.
**SEMICONDUCTOR SUPERLATTICE PHOTODETECTORS Final Report, 1 Jun. 1984 - 31 Dec. 1986**
S. L. Chuang, K. Hess, J. J. Coleman, and J. P. Leburton Dec. 1986 140 p
(Grant NAG1-500)
(NASA-CR-180639; NAS 1.26:180639) Avail: NTIS HC A07/MF A01 CSCL 20L

Superlattice photodetectors were investigated. A few major physical processes in the quantum-well heterostructures related to the photon detection and electron conduction mechanisms, the field effect on the wave functions and the energy levels of the electrons, and the optical absorption with and without the photon assistance were studied. Author

**N87-27523*#** North Carolina Agricultural and Technical State Univ., Greensboro. Dept. of Electrical Engineering.
**MATERIAL GROWTH AND CHARACTERIZATION FOR SOLID STATE DEVICES Report, 1 Jun. 1985 - 31 Dec. 1986**
Ward J. Collis, A. Abul-Fadl, and S. Iyer 13 Mar. 1987 35 p
(Grant NsG-1390)
(NASA-CR-180688; NAS 1.26:180688) Avail: NTIS HC A03/MF A01 CSCL 20L

During this period InGaAs and InGaAsP were grown on (100)InP by liquid phase electroepitaxy (LPEE). Results of the epitaxial growth of InGaAs on sputtered quartz masked substrates are presented. The resulting surface morphology can be related to the current density distribution near the edges of a masked pattern. The quaternary InGaAs was grown with compositions

corresponding to 1.3 micron and 1.5 micron emission wavelengths. Growth rates were found to be linearly dependent upon current density, and a strong dependence upon composition was noted. These compositions lie in the miscibility gap region of the alloy phase diagram at the 645 C growth temperature. Growths were performed at 685 C to avoid the miscibility gap. Epilayers were characterized by photoluminescence, X-ray diffraction, secondary ion mass spectrometry, and Hall effect measurements. Aluminum oxide was deposited on silicon and InGaAs substrates for the characterization of this material as an insulator in a field effect transistor structure. It was determined that the results did not warrant further work with the deposition from an aluminum isopropoxide source. A metallographic vapor phase epitaxy system installation is nearing completion for use in hybrid III-V semiconductor epilayer growths. Author

**N87-27524#** Lawrence Livermore National Lab., Calif. Physics Lab.
**NUCLEATION AND GROWTH OF SILICON MICROSTRUCTURES BY DIRECT-LASER WRITING**
David E. Kotecki and Irving P. Herman (Columbia Univ., New York.) 1986 10 p Presented at the Materials Research Society Fall Meeting, Boston, Mass., 1-4 Dec. 1986
(Contract W-7405-eng-48)
(DE87-010274; UCRL-95427; CONF-861207-108) Avail: NTIS HC A02/MF A01

This paper reports a study of the nucleation phase of thin film growth during pyrolytic deposition by direct-laser writing. A Monte Carlo computer simulation is used to model the initial surface dynamics occurring during the deposition of silicon from silane (SiH4) on strongly binding substrates such as silicon, and on weakly binding substrates such as silicon dioxide (SiO2) and silicon nitride (Si3N4). Results show that for high peak temperatures and weakly binding substrates, the most probable location for the initiation of thin film growth is displaced from the center of the locally laser heated region of the surface. At low peak temperatures, thin film nucleation is found to begin at the center of the locally laser-heated surface for all substrates. DOE

**N87-27525#** Ballistic Research Labs., Aberdeen Proving Ground, Md.
**X-RAY TOPOGRAPHY UTILIZING NON-EQUATORIAL REFLECTIONS Final Technical Report, 25 Sep. 1984 - 6 Jun. 1985**
P. W. Kingman Mar. 1987 25 p
(AD-A180687; BRL-TR-2789) Avail: NTIS HC A02/MF A01 CSCL 20L

The principal thrust of X-ray topography has been toward the study of general dislocation arrangements in quite perfect crystals. Since the early work of Barrett and Honeycombe there has been relatively little interest in deformation structures; at least in part because of the difficulty of extracting useful quantitative information about the geometry from topographs. This paper describes the general geometry of back reflection topography and shows how a systematic exploitation of the back reflection geometry can be used to maximize the information which can be obtained and optimizes the diffraction geometry for any given Bragg reflection. A camera design based upon this general approach is described, as well some specific procedures for its utilization. The basic approach to back reflection topography can be applied to any topographic arrangement. Since the present camera was intended for the study of macrostructures of crystals with high dislocation densities, it was designed to image large sample areas at low resolution. The basic analysis and procedures apply equally well to any back reflection technique. The possibility of effectively nonequatorial reflections greatly enhances the power and flexibility of the method. GRA

**N87-27526#** Massachusetts Inst. of Tech., Lexington. Lincoln Lab.
**SOLID STATE RESEARCH Quarterly Technical Report, 1 Feb. - 30 Apr. 1986**
Alan L. McWhorter 15 May 1986 93 p
(Contract F19628-85-C-0002; AF Proj. 649L)
(AD-A180799; Rept-1986:2; ESD-TR-86-069) Avail: NTIS HC A05/MF A01 CSCL 20L

The topics covered in this report on solid state research are Solid State Devices, Quantum Electronics, Materials Research, Microelectronics, and Analog Device Technology. GRA

**N87-27527#** California Univ., Los Angeles. Dept. of Physics.
**CHARACTERIZATION OF INFRARED PROPERTIES OF LAYERED SEMICONDUCTORS Final Report, 1 Apr. 1983 - 29 Feb. 1987**
Rubin Braunstein 20 Feb. 1987 160 p
(Grant AF-AFOSR-0169-83)
(AD-A181016; AFOSR-87-0721TR) Avail: NTIS HC A08/MF A01 CSCL 20L

The technique of infrared wavelength modulation absorption, photo-induced transient-spectroscopy, Raman scattering, and photo-mixing were developed for non-destructive characterization of layered semiconductors. Infrared wavelength modulation on semi-insulating GaAs reveals two resonant type peaks with fine structures near 0.37 and 0.40 eV as well as plateaus and thresholds at higher energies. The absorption at 0.37 eV is interpreted as due to the intra-center transition between levels of an accidental iron impurity. The absorption band near 0.40 eV can be annealed out by heat treatment and is characterized as belonging to a structural multi-level defect complex. Photo-induced-transient-spectroscopy technique also reveals an annealable level at 0.42 eV. Crystalline Arsenic was observed to grow on the surface of GaAs during exposure to continuous-wave laser radiation. A study of time development of Arsenic growth as revealed by Raman back-scattering indicated that a surface diffusion process was responsible for limiting the growth process. GRA

**N87-27528#** Ohio State Univ., Columbus.
**STRENGTH AND STRUCTURE OF Ga(1-x)In(x)As ALLOYS Quarterly Report, 1 Jan. - 31 Mar. 1987**
Katherine T. Faber and John P. Hirth 15 Apr. 1987 6 p
(Contract F49620-85-C-0129)
(AD-A181167; AFOSR-87-0735TR) Avail: NTIS HC A02/MF A01 CSCL 07B

Substantial solid solution strengthening of Gallium arsenide by In acting as Indium arsenide units has recently been predicted for an intermediate temperature, plateau region. This strengthening could account, in part, for the reduction of dislocation density in GaAs single crystals grown from the melt. High temperature deformation measurements have been carried out on GaAs from 700 to 1100 C in the (123) orientation. In this single slip orientation, the critical resolved shear stress of the Indium-doped material is nearly twice that of the undoped material. Values of the critical resolved shear stress are weakly dependent on temperature, consistent with the solid solution hardening model. The observed increase in resistance to glide is sufficient to eliminate dislocations in large diameter crystals during growth. Electron microscopy is used to relate the mechanical properties of these materials to their dislocated structures. GRA

**N87-27529#** Brown Univ., Providence, R. I. Dept. of Chemistry.
**UNUSUAL ELECTRONIC PROPERTIES OF DEFECT AND SUBSTITUTED OXIDES WITH THE RUTILE STRUCTURE Final Report, 15 Apr. 1983 - 15 Sep. 1986**
A. Wold, M. L. Gray, W. J. Croft, R. Kershaw, and K. Dwight Mar. 1987 21 p
(Contract DAAG46-83-K-0015; DA Proj. 1L1-61102-AH-42)
(AD-A181170; MTL-TR-87-19) Avail: NTIS HC A02/MF A01 CSCL 20L

The work that is reported in this final technical report covers the period from April 15, 1983 to September 15, 1986 and deals with the preparation and electronic properties of vanadium oxides. This work was carried out in order to determine whether the transition observed in VO2 would be altered as a result of small changes in vanadium oxygen stoichiometry. The work reported by Magneli and his co-workers was confirmed in that there are a number of vanadium oxygen phases with varying amounts of

vanadium +3/+4. This gives rise to a series of compounds, each of which has its own distinct electronic transitions. The effect of pressure on these transitions was also studied during our investigation. GRA

**N87-27530#** Illinois Univ., Urbana. Coordinated Science Lab.
**THE III-V HETEROJUNCTION STRUCTURES AND HIGH SPEED DEVICES Annual Report, 1 Feb. 1986 - 31 Jan. 1987**
Hadis Morkoc 24 Mar. 1987 29 p
(Grant AF-AFOSR-0111-86)
(AD-A181179; AFOSR-87-0732TR) Avail: NTIS HC A03/MF A01 CSCL 20L

Much better p-GaAs/n-Si heterojunction has been obtained. This led to new experimental and theoretical studies of these diodes and progress has been made in the understanding of the electrical properties of the GaAs/Si interface. The study about dislocation reduction by annealing has been continued in connection with N. Otsuka from Purdue University. Interesting features has been revealed by TEM plan view made such as the creation of a clearly observable misfit dislocation network after annealing. GRA

**N87-27531#** Notre Dame Univ., Ind. Dept. of Physics.
**VIBRATIONAL, MECHANICAL, AND THERMAL PROPERTIES OF III-V SEMICONDUCTORS Annual Technical Report, 15 Aug. 1985 - 14 Aug. 1986**
John D. Dow 20 Apr. 1987 67 p
(Grant AF-AFOSR-0331-85)
(AD-A181185; AFOSR-87-0718TR) Avail: NTIS HC A04/MF A01 CSCL 09A

We have pursued three major lines of investigation this year: (1) development of theoretical methods for prediction the relaxation of atoms at III-V surfaces, (2) prediction of the vibrational spectra of random III0V and Hg(1-x)Cd(x)Te alloys, and (3) development of a theory of Raman scattering in correlated and clustered alloys. Among other predictions, we have shown that: (1) The reconstruction of (110) zincblende surfaces is inhibited by ionic forces, and so the 29 deg surface anion relaxation angle of GaAs, which was thought to be common to all zincblende (110) surfaces, decreases significantly with increasing ionicity of the semiconductor. (2) Wurtzite (1010) surfaces, to a reasonable approximation, do not reconstruct. (3) The clustering mode observed in Hg(1-x)Cd(x)Te Raman spectra is due to Te atoms surrounded by three Hg atoms and one dc atom, not to vacancy complexes. (4) The effects of correlations and clustering in the Raman spectra of alloys can be easily predicted using a theory which combines Ising-Monte Carlo techniques and the recursion method. Author (GRA)

**N87-27532#** Massachusetts Inst. of Tech., Cambridge. Research Lab. of Electronics.
**SINGLE CRYSTAL FILMS OF SEMICONDUCTORS ON AMORPHOUS SUBSTRATES VIA A LOW TEMPERATURE GRAPHOEPITAXY Annual Technical Report, 1 Mar. 1986 - 28 Feb. 1987**
Henry I. Smith and Carl V. Thompson Apr. 1987 23 p
(Grant AF-AFOSR-0154-85)
(AD-A181194; AFOSR-87-0734TR) Avail: NTIS HC A02/MF A01 CSCL 09A

The objective of this program is to carry out basic research on the phenomenon of surface-energy-driven secondary grain growth (SEDSGG) in thin films on amorphous and single crystal substrates. Means of enhancing grain boundary mobility, such as ion bombardment, doping, and rapid thermal annealing are investigated, Theoretical models for SEDSGG are developed. The role of surface patterning in SEDSGG is also studied. GRA

**N87-27533#** Stanford Univ., Calif. Dept. of Materials Science and Engineering.
**CRYSTAL GROWTH AND MECHANICAL PROPERTIES OF SEMICONDUCTOR ALLOYS Annual Report, 15 Apr. 1986 - 14 Apr. 1987**
D. A. Stevenson 21 May 1987 26 p
(Grant AF-AFOSR-0158-86)
(AD-A181197; AFOSR-87-0750TR) Avail: NTIS HC A03/MF A01 CSCL 09A

The mechanical properties of semiconductor materials are related to changes in electronic and optical properties that may occur during the processing of materials into wafers and wafers into devices. Recent theoretical models related hardness in ternary semiconductor alloys to fundamental atomic properties, but few data are available. The report details the progress made in exploring methods for mechanical property studies of these alloys. Three approaches were used: hardness measurements in thick films (10-100 micrometer) using conventional microhardness, techniques; hardness measurements in thin films (less than 1 micrometer) using a nanoindenter; and the growth of bulk samples for use in conventional mechanical tests. GRA

**N87-27534#** Aerodyne Research, Inc., Billerica, Mass.
**LASER INDUCED SURFACE CHEMICAL EPITAXY: A NOVEL THIN FILM DEPOSITION TECHNIQUE Final Report, 15 Aug. 1986 - 15 Apr. 1987**
Charter D. Stinespring and Andrew Freedman 15 Apr. 1987 47 p
(Contract F49620-86-C-0089)
(AD-A181216; ARI-RR-595; AFOSR-87-0720TR) Avail: NTIS HC A03/MF A01 CSCL 09A

This report identifies a new deposition technique, laser induced surface chemical epitaxy, and describes experimental studies of the surface chemistry relevant to the feasibility of the technique. The experiments focus on the thermal and photo-induced surface chemistry of two organometallic molecules, dimethyl cadmium and dimethyl tellurium, on a variety of surfaces including GaAs, Au, Si, and SiO2. These studies followed ultra-high vacuum compatible procedures and used X-ray photoelectron spectroscopy to characterize thermal and photon-induced effects on the chemical state of the adsorbed organometallic molecule. The results show considerable diversity in the thermal surface chemistry of the system investigated. Physisorption and dissociative chemisorption to yield monomethyl and metal adspecies were observed. Irradiation of the physisorbed adspecies with 193 nm UV photons caused both photodecomposition and photodesorption. Similar irradiation of the photons caused both photodecomposition and photodesorption. GRA

**N87-27535#** Rochester Univ., N. Y. Lab. for Laser Energetics.
**MICRO-RAMAN ANALYSIS OF DIELECTRIC THIN FILMS Annual Report, 1 May 1985 - 30 Apr. 1986**
A. Schmid Apr. 1987 14 p
(Grant AF-AFOSR-0221-85)
(AD-A181342; AFOSR-87-0729TR) Avail: NTIS HC A02/MF A01 CSCL 20C

The long-term motivation of our program Micro-Raman-Analysis of Dielectric Thin Films is the acquisition of an understanding of stress and the role of defects in the growth of optical performance of dielectric thin films. By dielectric films comprising materials are suitable for high-power laser applications in the visible and near UN. Materials with intrinsic band gaps exceeding 3.5 eV are of interest here. Before the initiation of this program there was considerable research activity in the area of narrow band gap materials, mostly semiconductors, in which Raman spectroscopy answered questions of film morphology, doping levels and carrier dynamics. GRA

**N87-27536#** Honeywell, Inc., Bloomington, Minn. Physical Sciences Center.
**THIN-FILM OPTOELECTRONIC CIRCUITS RESEARCH PROGRAM Final Technical Report, 1 Feb. 1985 - 31 Jan. 1987**
Steven M. Arnold Apr. 1987 49 p
(Contract F49620-85-C-0050)
(AD-A181445; AFOSR-87-0770TR) Avail: NTIS HC A03/MF A01 CSCL 09E

The program objective has been to identify and investigate IC-compatible fabrication processes for thin-film optoelectronic circuits on GaAs. Single-mode channel waveguides of

SiO2-ZnO-SiO2, SiO2-Al2O3-TaO2-SiO have been deposited on GaAs by ion-beam sputtering. Straight guides, curves, tapers, Y-branches, crossovers, and directional couplers have all been demonstrated. Novel concepts have been developed for integrated GaAs Schottky photodiodes and self-aligning fiber-to-waveguide couplers. An IC-compatible baseline fabrication process has been established and a photomask set has been completed for an optoelectronic circuit demonstration, including Mach-Zehnder interferometric modulators, delta-beta electro-optic switches, and integrated GaAs photodetectors. GRA

**N87-27537#** SRI International Corp., Menlo Park, Calif.
**SEMICONDUCTOR ENGINEERING FOR HIGH-SPEED DEVICES Quarterly Status Report, 16 Dec. 1986 - 14 Mar. 1987**
A. Sher and A.-B. Chen May 1987 9 p
(Contracts F49620-85-C-0103; ARPA Order 5396)
(AD-A181543; AFOSR-87-0731TR; QSR-7) Avail: NTIS HC A02/MF A01 CSCL 20L

Phonon scattering is treated only in the long wavelength limit. We have found that such an approximation is invalid in hot electron transport studies due to large momentum transfers involved. We are currently evaluating these rates from ab initio calculation. The results of this calculation are expected to include the effect of intervalley scattering mediated by LO and acoustic phonons. The analysis is completed, and computer evaluations of the result for several semiconductors are in process. This may change some of our quantitative conclusions. GRA

**N87-27538#** Naval Postgraduate School, Monterey, Calif.
**CMOS (COMPLEMENTARY METAL OXIDE SILICON) CELL LIBRARY FOR A SILICON COMPILER M.S. Thesis**
Anthony J. Mullarky Mar. 1987 108 p
(AD-A181797) Avail: NTIS HC A06/MF A01 CSCL 20L

A standard Complementary Metal Oxide Silicon library (CMOS) for use in Very Large Scale Integration (VLSI) circuits was developed. The development includes investigation of the various clocking strategies upon which the optimun clocking strategy, pseudo two phase, was selected for all clocked cells in the library. The cells were then designed using the pseudo two phase clocking strategy. A primary objective is to provide cells for use in converting the MACPITTS silicon compiler from n-channel Metal Oxide Silicon (NMOS) to CMOS technology. Cell layouts, timing data, schematics and logic tables for each cell are provided. GRA

**N87-27539#** Massachusetts Inst. of Tech., Cambridge. Dept. of Materials Science and Engineering.
**GRAIN BOUNDARIES Final Report, 16 Jun. 1984 - 15 Jun. 1987**
R. W. Balluffi and P. D. Bristowe 1987 27 p
(Contract DE-FG02-84ER-45116)
(DE87-010246; DOE/ER-45116/T2) Avail: NTIS HC A03/MF A01

A relatively broad three-year investigation has been conducted of the structure and properties of grain boundaries on a basic level. The work mainly consisted of a combined experimental and computer simulation attack on the problem of determining the atomic structure and corresponding properties of high-angle grain boundaries in metals. The experimental work has relied heavily on techniques developed for producing thin film specimens containing planar grain boundaries of predetermined and controlled geometry. Studies of the atomistic and dislocation structures of these boundaries have been carried out using electron microscopy in the diffraction, diffraction contrast and lattice imaging modes. Of particular interest have been experiments aimed at deciding questions such as to what extent are grain boundaries ordered structures, and to what extent can grain boundary structures be described by dislocation and structural unit models. Efforts have been made to measure relative grain boundary energies. The computer simulation work has involved both molecular statics and molecular dynamics calculations using pair potentials and more sophisticated ab initio methods. Emphasis has been on calculating boundary structures and energies in situations where the results can be compared with experiments. Efforts have been made to determine whether the calculated results fit dislocation and structural unit models. DOE

**N87-27540#** Sandia National Labs., Albuquerque, N. Mex.
**PREPARATION OF BORON-RICH REFRACTORY SEMICONDUCTORS**
T. L. Aselage 1987 11 p Presented at the Spring Meeting of the Materials Research Society, Anaheim, Calif., 21 Apr. 1987
(Contract DE-AC04-76DP-00789)
(DE87-010429; SAND-86-2910C; CONF-870438-17) Avail: NTIS HC A02/MF A01

Boron-rich refractory solids based on the rhombohedral structure of alpha-B exhibit electrical properties that range from a hopping-type semiconductor (boron carbide) to wide bandgap room temperature insulators (the boron pnictides B6P and B6As). As such, they are of interest for a variety of high temperature semiconductor applications. Preparation techniques for these unusual materials are reviewed, and new results on the crystal growth of boron carbides and B6As and on thin film deposition of B6P are presented. DOE

**N87-27541*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**A V-GROOVED AlGaAs/GaAs PASSIVATED PN JUNCTION**
Sheila G. Bailey, Rosa P. Leon, and Anne Arrison May 1987 12 p Presented at the 19th Photovoltaic Specialists Conference, New Orleans, La., 4-8 May 1987; sponsored by AIEEE
(NASA-TM-100138; E-3688; NAS 1.15:100138) Avail: NTIS HC A02/MF A01 CSCL 20L

A passivated, V-grooved GaAs solar cell offers important advantages in terms of improved optical coupling, higher short circuit current, and increased tolerance to particle radiation when compared to the planar cell configuration. An AlGaAs epilayer has been deposited on a p-type GaAs epilayer grown on an n-type V-grooved GaAs surface using MOCVD. A wet chemical etching process was used to produce a V-pattern with a 7.0 micron periodicity. Reflectivity measurements substantiate the expected decrease in solar reflectance. Scanning electron microscopy techniques were used to confirm the presence of the AlGaAs layer and verify the existence of a pn junction. Author

**N87-27542#** British Aerospace Aircraft Group, Preston (England).
**THE SOLID-STATE SUPERLATTICE**
J. C. Robertson 19 Dec. 1986 28 p
(BAe-WAA-T-Gen-Phot-410; TNAAS-430; ETN-87-90088)
Copyright Avail: NTIS HC A03/MF A01

Bandgap engineering, and the development of solid-state semiconducting structures, called superlattices are reviewed. The semiconductor superlattice, while it has graduated from the status of a laboratory curiosity, is still in the very early stages of its development, and its ultimate potential has yet to be fully explored. Even so, it is evident that the compositional superlattice, and even more so the doping superlattice with its unique property of tunability, represents an important class of semiconductor. Applications in electronics, electro-optics, microwave devices, and photonics are possible. ESA

**N87-27543*#** Longwood Coll., Farmville, Va. Dept. of Chemistry.
**GROWTH OF LEAD TIN TELLURIDE CRYSTALS IN GELS Final Project Report**
Patrick G. Barber 31 May 1986 15 p
(Grant NAG1-498)
(NASA-CR-181258; NAS 1.26:181258) Avail: NTIS HC A02/MF A01 CSCL 20L

Improved gels and several geometries were investigated for use in growing crystals. The use of lead sulfide test crystals proved workable, but it was impossible to obtain and maintain a sufficiently concentrated telluride ion solution to successfully grow lead telluride crystals. It appears that oxygen in the solution is capable of oxidizing the telluride ion up to tellurium metal. The method may still be successful, but only if precautions are taken to eliminate

dissolved oxygen from the gels and aqueous solutions and to maintain a suitable concentration of telluride, Te(2)-(aq.). Author

**N87-27544*#** Old Dominion Univ., Norfolk, Va. Dept. of Electrical and Computer Engineering.
**ELECTRICAL AND OPTICAL STUDY OF SEMICONDUCTOR LASER DIODES AND MATERIALS Final Report, period ending 31 Aug. 1987**
Sacharia Albin Sep. 1987 28 p
(Contract NAS1-17993)
(NASA-CR-181294; NAS 1.26:181294) Avail: NTIS HC A03/MF A01 CSCL 20L

The characterization of a 2-D diode laser array from McDonald Douglas has been completed. The array consisted of 8 linear arrays of approximately 11 mm x 0.18 mm. Each array has between 7 and 8 diodes per mm. The threshold current is approximately 15 amps. The power output vs drive current (above threshold) of the array was measured. A peak power of 50 W was obtained at a drive current of 26 amps. Its far field pattern has a double lobe. Author

# 77 THERMODYNAMICS AND STATISTICAL PHYSICS

Includes quantum mechanics; theoretical physics; and Bose and Fermi statistics.

For related information see also *25 Inorganic and Physical Chemistry* and *34 Fluid Mechanics and Heat Transfer.*

**N87-27545#** Gosudarstvennyi Komitet po Ispolzovaniyu Atomnoi Energii, Moscow (USSR). Inst. Teoreticheskoj i Ehksperimentalnoj Fiziki.
**THE SUPERSTRING SUPERGRAVITY (27-PLETS AND RIGHT-LEFT SYMMETRY)**
K. A. Ter-Martirosyan 1986 10 p Submitted for publication
(DE87-702024; ITEP-124(1986)) Avail: NTIS (US Sales Only) HC A02/MF A01

Superstring d=3+1 supergravity is considered as a result of the E6 symmetry violation. The right-left symmetry of 27-plets of the E6 group as shown to provide a simple way to construct the invariant low-energy superpotential by the matrix multiplication method. The SU/sub L/(2)xSU/sub R//sup N/(2) invariant theory is found to lead to inadmixible large Dirac mass of Nu/sub tau/-neutrino - of order of or larger than the t-quark mass. The other possible symmetry is the generalization of the no-scale CERN theory with one more Z-boson. It is found to be roughly four times lighter than the Z/sup E/ boson of the no-scale theory. DOE

**N87-27546** Wisconsin Univ., Milwaukee.
**TOPOLOGICAL ASPECTS OF CLASSICAL AND QUANTUM GRAVITY Ph.D. Thesis**
Donald Michael Witt 1986 114 p
Avail: Univ. Microfilms Order No. DA8708859

In canonical quantum gravity, the group of disconnected components of the diffeomorphisms of a fixed superspace form a symmetry group of the quantum states associated with the hypersurface. Here, techniques are developed to calculate these groups. The 3-manifolds studied here are constructed from a 3-sphere by identifying points via isometries of the sphere. For this class of 3-manifolds the symmetry groups are comprised of SU(2) coverings of SO(3) crystallographic groups, the product of these with a cyclic group, cyclic groups and the production of two cyclic groups. Using these groups, a complete classification of the 3-manifolds which have quantum states with half integral angular momentum is given. It is shown that for spherical spaces, most of them never admit orientation reversing diffeomorphisms. Also, the first example of a diffeomorphism of 3- manifold which is homotopic but not isotopic to the identity is given. Dissert. Abstr.

# 80 SOCIAL SCIENCES (GENERAL)

Includes educational matters.

No abstracts in this category.

# 81 ADMINISTRATION AND MANAGEMENT

Includes management planning and research.

**N87-27547*#** Illinois Univ., Urbana. Dept. of Computer Science.
**SCHEDULING REAL-TIME, PERIODIC JOBS USING IMPRECISE RESULTS**
Jane W. S. Liu, Kwei-Jay Lin, and Swaminathan Natarajan 1987 22 p
(Grant NAG1-613)
(NASA-CR-180562; NAS 1.26:180562) Avail: NTIS HC A02/MF A01 CSCL 05A

A process is called a monotone process if the accuracy of its intermediate results is non-decreasing as more time is spent to obtain the result. The result produced by a monotone process upon its normal termination is the desired result; the error in this result is zero. External events such as timeouts or crashes may cause the process to terminate prematurely. If the intermediate result produced by the process upon its premature termination is saved and made available, the application may still find the result unusable and, hence, acceptable; such a result is said to be an imprecise one. The error in an imprecise result is nonzero. The problem of scheduling periodic jobs to meet deadlines on a system that provides the necessary programming language primitives and run-time support for processes to return imprecise results is discussed. This problem differs from the traditional scheduling problems since the scheduler may choose to terminate a task before it is completed, causing it to produce an acceptable but imprecise result. Consequently, the amounts of processor time assigned to tasks in a valid schedule can be less than the amounts of time required to complete the tasks. A meaningful formulation of this problem taking into account the quality of the overall result is discussed. Three algorithms for scheduling jobs for which the effects of errors in results produced in different periods are not cumulative are described, and their relative merits are evaluated. Author

**N87-27548*#** Illinois Univ., Urbana. Dept. of Computer Science.
**SAGA: A PROJECT TO AUTOMATE THE MANAGEMENT OF SOFTWARE PRODUCTION SYSTEMS Progress Report, Jan. - Jun. 1986**
Roy H. Campbell, D. Laliberte, H. Render, R. Sum, W. Smith, and R. Terwilliger [1987] 311 p
(Grant NAG1-138)
(NASA-CR-181108; NAS 1.26:181108) Avail: NTIS HC A14/MF A01 CSCL 05A

The Software Automation, Generation and Administration (SAGA) project is investigating the design and construction of practical software engineering environments for developing and maintaining aerospace systems and applications software. The research includes the practical organization of the software lifecycle, configuration management, software requirements specifications, executable specifications, design methodologies, programming, verification, validation and testing, version control, maintenance, the reuse of software, software libraries, documentation, and automated management. Author

# 82 DOCUMENTATION AND INFORMATION SCIENCE

Includes information management; information storage and retrieval technology; technical writing; graphic arts; and micrography.

For computer documentation see *61 Computer Programming and Software.*

**N87-27549#** Institute for Defense Analyses, Alexandria, Va.
**THE MILITARILY CRITICAL TECHNOLOGIES LIST Final Report, Oct. 1986 - Jan. 1987**
James Hamm and Norman D. Jorstad Oct. 1986 251 p
(Contract MDA903-84-C-0031)
(AD-A181018; AD-E500865) Avail: NTIS HC A12/MF A01 CSCL 05A

This publication is a detailed and structured technical statement of the technologies which DoD assesses as being critical to given military capabilities and of significant value to potential adversaries, and which should therefore be subject to technology transfer controls. The document includes a listing of Descriptions and Arrays of Know-How; Keystone Equipment; Keystone Materials and Goods Accompanied by Sophisticated Know-How for the relevant technologies. The MCTL serves to provide a technical basis for making export control policy decision and a technical consensus which may be drawn upon during case reviews. GRA

**N87-27550#** Defense Technical Information Center, Alexandria, Va. Office of Information Systems and Technology.
**ARTIFICIAL INTELLIGENCE DEVELOPMENTS RE: DOD GATEWAY INFORMATION SYSTEM (DGIS) AND DEFENSE APPLIED INFORMATION TECHNOLOGY CENTER (DAITC)**
Allan D. Kuhn Feb. 1987 19 p
(AD-A181101; DTIC/TR-87/9; DTIC-AI-FOUNDATIONAL-SER-2)
Avail: NTIS HC A02/MF A01 CSCL 05B

The artificial intelligence (AI) activities of the DGIS and DAITC are summarized. AI-like developments are discussed as precursors to true AI activity. The DGIS is presented as a low-level AI-like system, which attempts to mimic human responses. The DAITC is now being established as an information technology resource for DOD. The missions of the individual DAITC laboratories are described. These laboratories will study applications of AI, high density storage, interconnectivity, video laser disk, and human factors. The overall objective of implementing AI applications will be to make the human-machine interface more human-like. GRA

**N87-27551#** Defense Technical Information Center, Alexandria, Va. Office of Information Systems and Technology.
**DTIC (DEFENSE TECHNICAL INFORMATION CENTER) MODEL ACTION PLAN FOR INCORPORATING DGIS (DOD GATEWAY INFORMATION SYSTEM) CAPABILITIES Final Report, Oct. 1985 - May 1986**
Allan D. Kuhn and Randy L. Bixby May 1986 18 p
(AD-A181102; DTIC/TR-87/7) Avail: NTIS HC A02/MF A01 CSCL 05B

The DOD Gateway Information System (DGIS) is being developed to provide the DOD community with a modern tool to access diverse databases and extract information products from them. The Defense Technical Information Center (DTIC) is responsible for the design, development, and implementation of DGIS. DGIS information processing capabilities are seen as a way of enhancing DTIC information services to its users, providing them with comprehensive results as compared with single database-specific results. A model plan for incorporating DGIS capabilities inhouse DTIC is formulated. A testbed office information flow survey is included. The survey aided as a mechanism to create the model plan, and serves as an example of the steps needed to plan for incorporating DGIS capabilities. GRA

**N87-27552#** Defense Technical Information Center, Alexandria, Va. Office of Information Systems and Technology.
**TOWARD AN ARTIFICIAL INTELLIGENCE ENVIRONMENT FOR DTIC (DEFENSE TECHNICAL INFORMATION CENTER): PROPOSED TASKS, RECOMMENDED CONFIGURATIONS, PROJECTED START-UP COSTS**
Allan D. Kuhn May 1987 15 p
(AD-A181103; DTIC/TR-87/13; DTIC-AI-FOUNDATIONAL-SER-3)
Avail: NTIS HC A02/MF A01 CSCL 05B

This report discusses candidate Artificial Intelligence (AI) tasks for initiating AI projects at DTIC, several configuration issues, and start-up costs of expertise and equipment. Configuration issues concern mission, organization, and system. The DTIC AI mission will focus on prototyping practical applications of high value to the DTIC user community. DTIC has the choice of establishing a wholly self-contained AI activity, or participating in, contributing to, and sharing the resources of the Defense Applied Information Technology Center (DAITC). Coordinating AI functionality will be necessary for incorporating AI development activities and implementations on the DOD Gateway Information System (DGIS), the core computer system to the DAITC. Workstation consultant mode and backend storage are two options for production programs management. Two cost projection models are given as start-up costs for an AI environment. The costs are for expertise and hardware/software. AI expertise and AI ware are mutually dependent for a strong AI environment. GRA

**N87-27553#** Air Force Systems Command, Wright-Patterson AFB, Ohio. Foreign Technology Div.
**JOURNAL OF CHINA UNIVERSITY OF SCIENCE AND TECHNOLOGY (SELECTED ARTICLES)**
18 May 1987 34 p Transl. into ENGLISH from Ke Daxue Xuebao (China), v. 16, no. 1, Mar. 1986 p 66-77
(AD-A181217; FTD-ID(RS)T-0208-87) Avail: NTIS HC A03/MF A01 CSCL 20D

Contents: Effect of Nose Bluntness on Twin Wave Interference; Application of Finite Element Method to Transonic Airfoils - A Preliminary Steady Subcritical Calculation. GRA

**N87-27554#** BDM Corp., McLean, Va.
**APPLICATION OF OPTICAL COMPUTING TO PROBLEMS WITH SYMBOLIC COMPUTATIONS Quarterly Report no. 4, 15 Jan. 1986 - 31 Jan. 1987**
Brian G. Kushner 14 May 1987 7 p
(Contract F49620-86-C-0030; ARPA Order 4952; AF Proj. 4952)
(AD-A181218; AFOSR-87-0749TR) Avail: NTIS HC A02/MF A01 CSCL 09E

Research efforts identify some critical operations of symbolic computing. Of these operations, two primitives--central to the difference between symbolic and numeric computation--appeared ideally suited for optical implementation because of their parallel structure and local simplicity. These primitive operations are compare-and-exchange found in relational databases and pattern matching in inferencing systems. In this quarter, we proposed optical implementations of the compare-and-exchange operation for relational database applications. GRA

**N87-27555#** Naval Oceanographic Office, Bay St. Louis, Miss.
**DEPARTMENT OF DEFENSE GEOMAGNETIC DATA LIBRARY USER GUIDE**
Betty D. Vega Oct. 1986 24 p
(AD-A181344; NOO-TN-8222-01-87) Avail: NTIS HC A02/MF A01 CSCL 08D

The DOD Geomagnetic Data Library is one of the Mapping, Charting and Geodesy libraries implemented under the Defense Mapping Agency's (DMA) Instruction 8000.2 of 15 December 1978. The library is one of eleven libraries under the direction of DMA and provides complete geomagnetic library service to DOD, DOD contractors, and authorized non-DOD users. This user's guide presents a brief description of the resources and services available from the Geomagnetic Data Library to authorized users. Information is provided on appropriate procedures and guideline of requesting or supplying data to the library. The responsibilities of the library

include: acquisition, primary evaluations, and inventorying geomagnetic data; analysis support; information and referral service. GRA

**N87-27556#** Sandia National Labs., Albuquerque, N. Mex.
**SandKASt: AN AUTOMATED KNOWLEDGE ACQUISITION SYSTEM**
F. N. Hill, J. D. Ward, and A. L. Yates Feb. 1987 14 p Presented at the American Association for Artificial Intelligence Meeting, Seattle, Wash., 13 Jul. 1987
(Contract DE-AC04-76DP-00789)
(DE87-006127; SAND-87-0364C; CONF-870734-1) Avail: NTIS HC A02

SandKASt (Sandia Knowledge Acquisition System) is a knowledge acquisition system that allows the expert to directly build a knowledge base. It is based on a graph formalism that delineates the problem structure and dependencies of the heuristics and highlights inconsistencies or omissions in the knowledge base. The graph formalism evolved through experience in developing a rule-based system for fault diagnosis of electronic components in a large system. In SandKASt, the knowledge base is displayed as a directed acyclic graph, in which a node represents a state of the troubleshooting session, or context, with an associated set of possible faults. An arc represents a test to be applied in the context of the source node. The graph can be expanded depth-first, breadth-first or by adding a single node. Graph pruning and information retrieval can be performed at any time during the knowledge acquisition session. SandKASt seeks to involve the expert directly in the system development and maintenance. SandKASt allows more efficient and productive knowledge acquisition sessions. The graph structure provides a formalism for viewing the knowledge acquisition process and allows efficient storage of the diagnostic heuristics without redundancy. DOE

**N87-27557*** National Aeronautics and Space Administration, Washington, D.C.
**NASA THESAURUS SUPPLEMENT (SUPPLEMENT 3)**
Jul. 1987 325 p
(NASA-SP-7053(Supp-3); NAS 1.21:7053(Supp-3)) Avail: NTIS HC A14 CSCL 05B

The four part cumulative NASA Thesaurus Supplement to the 1985 edition of the NASA Thesaurus includes Part 1, Hierarchical Listing, Part 2, Access Vocabulary, Part 3, NASA Thesaurus Definitions, and Part 4, Changes. The semiannual supplement gives complete hierarchies for new terms. Author

**N87-27558*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**BIBLIOGRAPHY OF LEWIS RESEARCH CENTER TECHNICAL PUBLICATIONS ANNOUNCED IN 1986**
May 1987 349 p
(NASA-TM-89887; E-3574; NAS 1.15:89887) Avail: NTIS HC A15/MF A01 CSCL 05B

This compilation of abstracts describes and indexes the technical reporting that resulted from the scientific and engineering work performed and managed by the Lewis Research Center in 1986. All the publications were announced in the 1986 issues of STAR (Scientific and Technical Aerospace Reports) and/of IAA (International Aerospace Abstracts). Included are research reports, journal articles, conference presentations, patents and patent applications, and theses. Author

**N87-27559*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.
**RESEARCH AND TECHNOLOGY Annual Report, 1986**
1986 209 p Original document contains color illustrations
(NASA-TM-89626; NAS 1.15:89626) Avail: NTIS HC A10/MF A01 CSCL 05B

Activities of the Goddard Space Flight Center are described in the areas of planets and interplanetary media, comets, astronomy and high-energy physics, solar physics, atmospheres, terrestrial physics, ocean science, sensors and space technology, techniques, user space data systems, space communications and navigation, and system and software engineering. Flight projects and mission definition studies are presented, and institutional technology is described. J.P.B.

**N87-27560*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
**SCIENTIFIC AND TECHNICAL PAPERS PRESENTED OR PUBLISHED BY JSC AUTHORS IN 1986**
Jul. 1987 156 p
(NASA-TM-100457; S-563; NAS 1.15:100457) Avail: NTIS HC A08/MF A01 CSCL 05B

A compilation of Lyndon B. Johnson Space Center contributions to the scientific and technical literature in aerospace and life sciences made during calender year 1985 is presented. Citations include NASA formal series reports, journal articles, conference and symposium presentations, papers published in proceedings or other collective works, and seminar and workshop results. Author

# 83 ECONOMICS AND COST ANALYSIS

Includes cost effectiveness studies.

**N87-27561#** Naval Postgraduate School, Monterey, Calif.
**COST ANALYSIS FOR AIRCRAFT SYSTEM TEST AND EVALUATION: EMPIRICAL SURVEY DATA STRUCTURING AND PARAMETRIC MODELING, VOLUME 1 M.S. Thesis**
Robert W. Fonnesbeck and David J. Lee Mar. 1987 97 p
(AD-A181465) Avail: NTIS HC A05/MF A01 CSCL 05C

There is an increasing requirement from high levels within the Government that the Navy's aircraft cost estimators and analysts provide explicit estimates for the sub-elements of Aircraft System Test and Evaluation efforts. The data required to produce more accurate and detailed estimates represent lower levels in the Aircraft Work Breakdown Structure (WBS) than previously available. This is a two volume thesis. This volume examines the WBS and Contractor Cost Data Reporting (CCDR) system with a description of current reporting practices and implementation shortcomings. Recommended courses of action to improve reporting requirements and thereby improve data quality and cost estimates are proposed. Major cost drivers for AST and E, from both the perspective of Defense Contractors and Military Flight Test Centers, are discussed. GRA

# 84 LAW, POLITICAL SCIENCE AND SPACE POLICY

Includes NASA appropriation hearings; aviation law; space law and policy; international law; international cooperation; and patent policy.

No abstracts in this category.

# 85 URBAN TECHNOLOGY AND TRANSPORTATION

Includes applications of space technology to urban problems; technology transfer; technology assessment; and surface and mass transportation.

For related information see also *03 Air Transportation and Safety, 16 Space Transportation,* and *44 Energy Production and Conversion.*

**N87-27562#** Air Command and Staff Coll., Maxwell AFB, Ala.
**TECHNOLOGY TRANSFER: THE WEAK LINK IN US DEFENSE**
Michael L. DiScala Apr. 1987 41 p
(AD-A180936; ACSC-87-0685) Avail: NTIS HC A03/MF A01 CSCL 05D

(AD-A180936; ACSC-87-0685) Avail: NTIS HC A03/MF A01 CSCL 05D

Technology transfer is an issue of vital concern to the US defense. The Soviet Union utilizes several legal and illegal methods to obtain Western technology. Their successful efforts in the past two decades resulted in the introduction or improvement of many Soviet weapon systems. This report examines technological parity in the areas of computers and microelectronics. Although Soviet parity with the US has not been achieved in these areas, the gap has been narrowed. Several examples are presented; recommendations to improve the technology transfer process are offered. Author (GRA)

**N87-27563#** RAND Corp., Santa Monica, Calif.
**SPINOFFS: APPLYING HISTORICAL EXAMPLES TO THE PRESENT**
Katherine Watkins Webb Jun. 1986 38 p
(P-7323-RGS) Avail: NTIS HC A03/MF A01

As background to addressing the question of whether the Strategic Defense Initiative (SDI) should be pursued for its potential commercial technology spinoff benefits, research on relevant historical examples of spinoff was reviewed and analyzed. Attempts at a theory of technological innovation and diffusion were found to be highly qualitative and anecdotal. Five historical government research and development (R and D) efforts were examined for their spinoff value: (1) NASA programs, where dissemination of research for spinoff applications is part of the NASA mission; (2) government demonstration programs, which may be most effective in circumstances where private industry would have done the research anyway; (3) the CERN particle physics facility, which sponsored an evaluation of its return on investment to the Swiss economy; (4) the Manhattan Project, where a final judgment on the value of peaceful nuclear energy cannot yet be made; and (5) U.S. military R and D programs in general, where contributions range from basic technologies such as the jet engine and microchip to less easily assessed spinoff effects. For SDI, a judgment on spinoff benefits will be related to the amount of actual technological innovation employed, the nonmilitary potential of the products developed, and access to information about this highly secret project. Another consideration is the possible spinoff in terms of process (management, quality control) rather than product. Research approaches to increase ability to predict spinoff value are proposed. J.P.B.

**N87-27564*#** National Aeronautics and Space Administration. Lewis Research Center, Cleveland, Ohio.
**COMPARISON OF STIRLING ENGINES FOR USE WITH A 25-kW DISK-ELECTRIC CONVERSION SYSTEM**
Richard K. Shaltens Aug. 1987 18 p
(NASA-TM-100111; E-3655; NAS 1.15:100111; AIAA-87-9069; DOE/NASA-33408-2) Avail: NTIS HC A02/MF A01 CSCL 13F

Heat engines were evaluated for terrestrial solar heat receivers. The Stirling Engine was identified as one of the most promising engines for terrestrial applications. The potential to meet the Department of Energy (DOE) goals for performance and cost can be met by the free-piston Stirling engine. NASA Lewis is providing technical management for an Advanced Stirling Conversion System (ASCS) through a cooperative interagency agreement with DOE. Parallel contracts were awarded for conceptual designs of an ASCS. Each design will feature a free-piston Stirling engine, a liquid-metal heat pipe receiver, and a means to provide about 25 kW of electric power to a utility grid while meeting long-term performance and goals. The Mechanical Technology, Ins. (MTI) design incorporates a linear alternator to directly convert the solar energy to electricity while the Stirling Technology Company (STC) generates electrical power indirectly by using a hydraulic output to a ground-bases hydraulic pump/motor coupled to a rotating alternator. Both designs use technology which can reasonably be expected to be available in the 1980's. The ASCS designs using a free-piston Stirling engine, a heat transport system, a receiver, and the methods of providing electricity to the utility grid will be discussed. Author

**N87-27565*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
**APPLICATION OF RADAR FOR AUTOMOTIVE COLLISION AVOIDANCE. VOLUME 1: TECHNICAL REPORT Final Technical Memorandum, Nov. 1984 - Dec. 1985**
C. L. Lichtenberg, ed. Apr. 1987 254 p
(Grant DTNH22-85-X-07163)
(NASA-TM-58275-Vol-1; S-555-Vol-1; NAS 1.15:58275-Vol-1)
Avail: NTIS HC A12/MF A01 CSCL 13F

The purpose of this project was research and development of an automobile collision avoidance radar system. The major finding was that the application of radar to the automobile collision avoidance problem deserves continued research even though the specific approach investigated in this effort did not perform adequately in its angle measurement capability. Additional findings were that: (1) preliminary performance requirements of a candidate radar system are not unreasonable; (2) the number and severity of traffic accidents could be reduced by using a collision avoidance radar system which observes a fairly wide (at least + or - 10 deg) field of view ahead of the vehicle; (3) the health radiation hazards of a probable radar design are not significant even when a large number of radar-equipped vehicles are considered; (4) effects of inclement weather on radar operation can be accommodated in most cases; (5) the phase monopulse radar technique as implemented demonstrated inferior angle measurement performance which warrants the recommendation of investigating alternative radar techniques; and (6) extended target and multipath effects, which presumably distort the amplitude and phase distribution across the antenna aperture, are responsible for the observed inadequate phase monopulse radar performance. Author

**N87-27566*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, Tex.
**APPLICATION OF RADAR FOR AUTOMOTIVE COLLISION AVOIDANCE. VOLUME 2: DEVELOPMENT PLAN AND PROGRESS REPORTS Final Technical Memorandum, Nov. 1984 - Dec. 1985**
Christopher L. Lichtenberg, ed. Apr. 1987 139 p
(Grant DTNH22-85-X-07163)
(NASA-TM-58275-Vol-2; S-555-Vol-2; NAS 1.15:58275-Vol-2)
Avail: NTIS HC A07/MF A01 CSCL 13F

The purpose of this project was research and development of an automobile collision avoidance radar system. Items within the scope of the one-year effort were to: (1) review previous authors' work in this field; (2) select a suitable radar approach; (3) develop a system design; (4) perform basic analyses and observations pertinent to radar design, performance, and effects; (5) fabricate and collect radar data from a data collection radar; (6) analyze and derive conclusions from the radar data; and (7) make recommendations about the likelihood of success of the investigated radar techniques. The final technical report presenting all conclusions is contained in Volume 1. Author

## 88 SPACE SCIENCES (GENERAL)

No abstracts in this category.

## 89 ASTRONOMY

Includes radio, gamma-ray, and infrared astronomy, and astrometry.

**N87-27567*#** Stanford Univ., Calif. Center for Space Science and Astrophysics.
**NONLINEAR FORCE-FREE MAGNETIC FIELDS: CALCULATION AND APPLICATION TO ASTROPHYSICS Ph.D. Thesis**

Wei-Hong Yang Mar. 1987 115 p
(Grant NGL-05-020-272)
(NASA-CR-181196; NAS 1.26:181196; CSSA-ASTRO-87-11)
Avail: NTIS HC A06/MF A01 CSCL 03A

The problem concerned in this work is that of calculating magnetic field configurations in which the Lorentz force (vector)j x (vector)B is everywhere zero, subject to specified boundary conditions. The magnetic field is represented in terms of Clebsch variables in the form (vector)B = del alpha x del beta. These variables are constant on any field line. The most appropriate choice of boundary conditions is to specify the values of alpha and beta on the bounding surface. It is proposed that the field lines move in the direction of local Lorentz force and relax towards a force-free field configuration. This concept leads to an iteration procedure for modifying the variables alpha and beta that tends asymptotically towards the force-free state. This method is first applied to a simple problem in two rectangular dimensions; the calculation shows that the convergence of magnetic field energy to a minimum state (force-free) is close to exponential. This method is then applied to study some astrophysical force-free magnetic fields, such as the structures and evolution of magnetic fields of rotating sunspots and accretion disks. The implication of the results, as related to the mechanisms of solar flares, extragalactic radio sources and radio jets, are discussed. Author

**N87-27568*#** Tufts Univ., Medford, Mass. Dept. of Physics and Astronomy.
**COORDINATED ULTRAVIOLET AND RADIO OBSERVATIONS OF SELECTED NEARBY STARS Final Technical Report**
Kenneth R. Lang Sep. 1987 50 p
(Grant NAG5-477)
(NASA-CR-181089; NAS 1.26:180189) Avail: NTIS HC A03/MF A01 CSCL 03A

All of the US2 shifts assigned were successfully completed with simultaneous International Ultraviolet Explorer (IUE) and the Very Large Array (VLA) observations of the proposed target stars. The target stars included dwarf M flare stars and RS CVn stars. The combined ultraviolet (IUE) and microwave (VLA) observations have provided important new insights to the radiation mechanisms at these two widely-separated regions of the electromagnetic spectrum. The VLA results included the discovery of narrow-band microwave radiation and rapid time variations in the microwave radiation of dwarf M flare stars. The results indicate that conventional radiation mechanisms cannot explain the microwave emission from these stars. In general, ultraviolet variations and bursts occur when no similar variations are detected at microwave wavelengths and vice versa. Although these is some overlap, the variations in these two spectral regions are usually uncorrelated, suggesting that there is little interaction between the activity centers at the two associated atmospheric levels. B.G.

**N87-27569** Arizona Univ., Tucson.
**DESIGN ASPECTS OF FUTURE VERY LARGE TELESCOPES Ph.D. Thesis**
Andrew Yuk Sun Cheng 1987 246 p
Avail: Univ. Microfilms Order No. DA8709888

Research was carried out on three major difficulties in designing efficient and economic telescopes with 8m f/1 lightweight mirrors. These problems are polishing f/1 aspherics, thermal distortion of borosilicate glass mirror and mirror seeing. Viable solutions to all three problems were developed. Solving the fundamental problems allows future very large telescopes to use such mirrors as the basic elements in the design, thus reducing the cost.
Dissert. Abstr.

**N87-27570** Maryland Univ., College Park.
**AN INVESTIGATION OF CEPHEID VARIABLE STARS USING HYDROSTATIC MODEL ATMOSPHERES Ph.D. Thesis**
Robert B. Hindsley 1986 204 p
Avail: Univ. Microfilms Order No. DA8709078

Hydrostatic model stellar atmospheres were used in an analysis of Cepheid variable stars. The model atmospheres were used to investigate the calculation of Cepheid pulsation velocities measured with photoelectric radial velocity spectrometers. This involved the use of synthetic spectra created from the model atmospheres to analyze how the projection factor changes with pulsation velocity, stellar velocity, and various atmospheric parameters. Synthetic colors, infrared surface brightness, and infrared absolute magnitudes were calculated. Dissert. Abstr.

# 90 ASTROPHYSICS

Includes cosmology; celestial mechanics; space plasmas; and interstellar and interplanetary gases and dust.
For related information see also *75 Plasma Physics*.

**N87-27571*#** Washington Univ., Seattle. Dept. of Astronomy.
**[ANALYSIS AND INTERPRETATION OF X-RAY PULSARS] Final Technical Report**
Paul E. Boynton and John E. Deeter 17 Aug. 1987 3 p
(Grant NAGw-805)
(NASA-CR-181195; NAS 1.26:181195) Avail: NTIS HC A02/MF A01 CSCL 03B

By careful measurements of the fluctuations in pulsar pulse periods on time scales of days and longer, researchers determined that these fluctuations are caused by changes in the rotation rate of the stellar crust apparently arising from matter accretion. The study of these fluctuations is a particularly promising way to determine the properties of accreting pulsars, because stellar rotation is relatively simple in comparison to much other X-ray source physics and can be investigated in detail. Rotation rates can be determined precisely. Author

**N87-27572#** Fermi National Accelerator Lab., Batavia, Ill.
**TOWARD THE INFLATIONARY PARADIGM: LECTURES ON INFLATIONARY COSMOLOGY**
M. S. Turner Feb. 1987 34 p Presented at the Gauge Theories and the Early Universe Conference, Erice, Italy, 1 May 1986 Prepared in cooperation with Chicago Univ., Ill.
(Contract DE-AC02-76CH-03000)
(DE87-007037; FNAL/C-87/35-A; CONF-8605247-1-Summ; CONF-8606261-2-Summ; CONF-8606294-1-Summ; CONF-86081) Avail: NTIS HC A03

Guth's inflationary Universe scenario has revolutionized our thinking about the very early Universe. The inflationary scenario offers the possibility of explaining a handful of very fundamental cosmological facts - the homogeneity, isotropy, and flatness of the Universe, the origin of density inhomogeneities and the origin of the baryon asymmetry, while at the same time avoiding the monopole problem. It is based upon microphysical events which occurred early (t less than or equal to 10(-34) sec) in the history of the Universe, but well after the planck epoc (t greater than or equal to 10(-34) sec). While Guth's original model was fundamentally flawed, the variant based on the slow-rollover transition proposed by Linde, and Albrecht and Steinhardt (dubbed new inflation) appears viable. Although old inflation and the earliest models of new inflation were based upon first order phase transitions associated with spontaneous-symmetry breaking (SSB), it now appears that the inflationary transition is a much more generic phenomenon, being associated with the evolution of a weakly-coupled scalar field which for some reason or other was initially displaced from the minimum of its potential. Models now exist which are based on a wide variety of microphysics: SSB, SUSY/SUGR, compactification of extra dimensions, R squared gravity, induced gravity, and some random, weakly-coupled scalar field. While there are several models which successfully implement the inflation, none is particularly compelling and all seem somewhat ad hoc. The common distasteful feature of all the successful models is the necessity of a small dimensionless number in the model - usually in the form of a dimensionless coupling of order 10 to the -15th power. All inflationary scenarios rely upon the assumption that vacuum energy was once dynamically very significant, whereas today there exists every evidence that it is not. DOE

**N87-27573#** Washington Univ., Seattle. Dept. of Physics.
**ASTROPHYSICAL COSMOLOGY**
J. M. Bardeen 1986 10 p Presented at the 11th International Conference on General Relativity and Gravitation, Stockholm, Sweden, 1 Jul. 1986
(Contract DE-AC06-81ER-40048)
(DE87-008239; CONF-8607113-3) Avail: NTIS HC A02/MF A01

The last several years have seen a tremendous ferment of activity in astrophysical cosmology. Much of the theoretical impetus has come from particle physics theories of the early universe and candidates for dark matter, but what promise to be even more significant are improved direct observations of high z galaxies and intergalactic matter, deeper and more comprehensive redshift surveys, and the increasing power of computer simulations of the dynamical evolution of large scale structure. Upper limits on the anisotropy of the microwave background radiation are gradually getting tighter and constraining more severely theoretical scenarios for the evolution of the universe. DOE

**N87-27574#** Gosudarstvennyi Komitet po Ispolzovaniyu Atomnoi Energii, Moscow (USSR).
**INITIATION OF DETONATION IN SUPERNOVAE**
S. I. Blinnikov and A. M. Khokhlov 1986 20 p
(DE87-702203; ITEP-29(1986)) Avail: NTIS (US Sales Only) HC A02/MF A01

The formation of the thermonuclear burning front is considered under the explosion of degenerate CO-star as a supernova. It is shown that the thermal instability leads to the detonation if the initial central temperature profile is an isentropic one (instead of the widely accepted deflagration regime of burning). DOE

**N87-27575** Wisconsin Univ., Madison.
**THE IONIZATION STRUCTURE OF THE GALACTIC HALO Ph.D. Thesis**
Nazzeha Abdulla Daod 1986 88 p
Avail: Univ. Microfilms Order No. DA8702299

Photoionization models are constructed for studying the ability of hot (40,000 K less than or equal to T(eff) less than or equal to 100,000 K) white dwarfs to produce the highly ionized species (C IV, Si IV, and N V) seen toward stars at high z distances. To study the maximum effect white dwarfs can have on the halo gas, these stars are assumed to be surrounded by an H II region produced by dilute ionizing radiation from O stars (T(eff) = 40,000 K). The observed column density of C IV, Si IV, and N V seen towards hot individual white dwarfs can be reproduced. However, white dwarfs produce such small Stroemgren spheres of C IV, Si IV, and N V that they contribute about 1 percent to the C IV column density observed in the halo gas and less than 1 percent to the Si IV and N V colum densities. This result holds even with probable overestimates of the space density of white dwarfs. Photoionization models of nebulae surrounding O stars (T(eff) = 40,000 and 35,000 K) show that O stars are an important source of Si IV. The O type stars of spectral type O6 and earlier can produce or at least contribute to the observed C IV column density, while production of N V by these stars is negligible. Possible ionizing sources of the halo gas are discussed. Dissert. Abstr.

**N87-27576** California Univ., Santa Cruz.
**A STUDY OF THE STELLAR POPULATIONS IN TWO HIGH GALACTIC LATITUDE FIELDS WITH COMPARISON TO GALAXY MODELS Ph.D. Thesis**
Eileen Dolores Friel 1986 299 p
Avail: Univ. Microfilms Order No. DA8709122

The results of a photometric and spectroscopic survey of the stellar populations of high galactic latitude fields in SA94 and Serpens are analyzed. Comparison of these photometric data to star count predictions from galaxy models of Bahcall-Soneira and of Gilmore yield inconclusive results. Dissert. Abstr.

**N87-27577** California Univ., Santa Cruz.
**DYNAMICS AND EVOLUTION OF HOT GAS IN EARLY TYPE GALAXIES Ph.D. Thesis**
Michael Loewenstein 1986 71 p
Avail: Univ. Microfilms Order No. DA8709130

The time-dependent equations describing galactic flows, including detailed models for the evolving source terms, are integrated over a Hubble time for two elliptical galaxies with total masses of 3.1 X 10 to the 12th and 8.3 X 10 to the 12th solar masses, 90% of which resides in extended non-luminous halos. The standard supernova rate of Tammann (1974) and a rate four times smaller are considered for each galaxy model. The combination of the extended gravitational potential of the dark halo and the time dependent source terms generally lead to the development of massive, quasi-hydrostatic, nearly isothermal distributions of gas at approximately 10 to the 7th power K with cooling inflows inside their galactic cores. For the less massive galaxy with the higher supernova rate, however, a low-luminosity supersonic galactic wind develops. The effects of a reduced metal abundance, thermal conduction, and the absence of a massive halo are explored separately for one of our models. The X-ray luminosities of the hot gas in our models with dark halos and the lower supernova rate are in excellent agreement with Einstein observations of early type galaxies. Dissert. Abstr.

**N87-27578** California Univ., Santa Cruz.
**THE EFFECTS OF HII REGIONS AND SUPERNOVAE IN PROTO-DWARF GALAXIES Ph.D. Thesis**
Alberto Noriega-Crespo 1986 169 p
Avail: Univ. Microfilms Order No. DA8709132

Numerical hydrodynamical computer simulations of the effects of H2 regions and the effects of supernovae explosions have been used to study: (1) the dynamics of the residual gas, (2) development of conditions under which further star formation could take place, (3) the implications regarding star formation efficiency in dwarf systems and (4) the conditions for the removal of the residual gas as influenced by the overall properties of the dwarf systems. Dissert. Abstr.

**N87-27579** California Univ., Santa Cruz.
**CCD PHOTOMETRY OF THE GALACTIC NUCLEAR BULGE Ph.D. Thesis**
Donald Michael Terndrup 1986 112 p
Avail: Univ. Microfilms Order No. DA8709126

Deep charge coupled device photometry of the Galactic nuclear bulge has been obtained along four lines of sight near the bulge's minor axis. For an adopted distance of 6.9 kpc, the mean age derived from the main sequence turnoff is 11 plus or minus 3 Gyr. The fraction of stars with ages less than 5 Gyr is insignificant, unless the youngest stars are much more metal rich than the average. The mean metal abundance decreases with radium by approx. 0.4 dex from 0.5 to 1.2 kpc. Abundances derived from giant branch colors are several tenths of a dex lower than those derived from the main sequence turnoff. The later are consistent with spectroscopic determinations of metallicity, implying that the bulge giants are bluer or more luminous than solar neighborhood giants of similar age and metal abundance. Dissert. Abstr.

**N87-27580** Virginia Univ., Charlottesville.
**STAR FORMATION IN X-RAY CLUSTER COOLING FLOWS Ph.D. Thesis**
Raymond Edwin White, III 1986 229 p
Avail: Univ. Microfilms Order No. DA8705725

We consider whether accreting galaxies are formed by star formation in their associated cooling flows. We derive the basic equations relevant to cooling flows, including the effects of star formation. We develop a local approximation for the star formation rate, based on a detailed thermal instability analysis. This prescription allows analytic solutions to be found for both isobaric and gravity-dominated cooling flows. These analytic solutions are used to qualitatively illustrate the effects of star formation upon the structure of cooling flows. We develop techniques to directly determine the star formation rate, the mass distribution and the gas density, temperature and velocity distributions from X-ray surface brightness data for cooling flows. These techniques take account of the potentially important X-ray emission from

star-forming cooling condensations dropping out of the background flow. We calculate numerical models of star-forming cooling flows and assess how the structure of cooling flows is affected by star formation, as well as by variations in intracluster temperature, overall accretion rate, elemental abundances and the form of the gravitational potential. We calculate the X-ray emission from these models and search for a diagnostic that is cleanly indicative of ongoing star formation in X-ray cluster cooling flows. Finally, we calculate the spatial distribution of newly formed stars in each of our models and compare it to that of the accreting galaxy. We assess whether cooling flows are more likely to contribute to the luminous parts of an accreting galaxy or to a dark-matter component. Dissert. Abstr.

# 91 LUNAR AND PLANETARY EXPLORATION

Includes planetology; and manned and unmanned flights.

For spacecraft design or space stations see *18 Spacecraft Design, Testing and Performance.*

**N87-27581*#** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, Md.

**MODELING AND INVESTIGATIVE STUDIES OF JOVIAN LOW FREQUENCY EMISSIONS Final Report**

J. D. Menietti, James L. Green, N. Frank Six, and S. Gulkis (Jet Propulsion Lab., California Inst. of Tech., Pasadena.) 31 Aug. 1986 62 p

(Contract NASw-4045; SwRI Proj. 15-8558)

(NASA-TM-89299; NAS 1.15:89299) Avail: NTIS HC A04/MF A01 CSCL 03B

Jovian decametric (DAM) and hectometric (HOM) emissions were first observed over the entire spectrum by the Voyager 1 and 2 flybys of the planet. They display unusual arc-like structures on frequency-versus-time spectrograms. Software for the modeling of the Jovian plasma and magnetic field environment was performed. In addition, an extensive library of programs was developed for the retrieval of Voyager Planetary Radio Astronomy (PRA) data in both the high and low frequency bands from new noise-free, recalibrated data tapes. This software allows the option of retrieving data sorted with respect to particular sub-Io longitudes. This has proven to be invaluable in the analyses of the data. Graphics routines were also developed to display the data on color spectrograms. Author

**N87-27582** Cornell Univ., Ithaca, N.Y.

**VOYAGER PHOTOMETRY OF IO Ph.D. Thesis**

Damon Paul Simonelli 1987 405 p

Avail: Univ. Microfilms Order No. DA8708989

Detailed disk-integrated and disk-resolved photometric studies of the Jovian moon Io have been carried out using Voyager images. Disk-integrated properties derived from the Voyager data, such as phase curves, geometric albedos, phase integrals, and Bond albedo, are generally consistent with Earth-based estimates. Dissert. Abstr.

# 92 SOLAR PHYSICS

Includes solar activity, solar flares, solar radiation and sunspots.

For related information see *93 Space Radiation.*

**N87-27583#** Princeton Univ., N. J. Dept. of Physics.

**SOLAR DISTORTION MEASUREMENTS Final Report, 29 Nov. 1983 - 30 Sep. 1986**

R. H. Dicke and J. R. Kuhn 15 Apr. 1987 77 p

(Contract F19628-84-K-0024)

(AD-A181116; AFGL-TR-87-0098) Avail: NTIS HC A05/MF A01 CSCL 03B

Highly accurate solar limb temperature and shape observations were obtained from Mt Wilson using a highly specialized telescope. The solar oblateness appears to fluctuate on a time scale of years. A latitude dependent solar limb temperature variation exists with a temperature amplitude of about 0.6k. This temperature variation is independent of the solar cycle. Oblateness of the Sun in 1983 and Relativity; On the Facular Contrast Near the Solar Limb; Brightness Variation; Another Reason to Search for Solar g-Modes and New Limits from Solar Ellipticity Measurements; Solar Ellipticity Fluctuations Yield No Evidence of g-Modes; The Variable Oblateness of the Sun: Measurements of 1984; Is the Solar Oblateness Variable? Measurements of 1985; More Evidence for a Solar Latitude Dependent Limb Temperature Variation. GRA

**N87-27584#** Arizona Univ., Tucson. Dept. of Physics.

**APPLICATION OF SOLAR SEISMOLOGY TO STUDY OF THE CONVECTION ZONE Final Report, 10 Jan. 1981 - 31 Dec. 1986**

Henry A. Hill 22 Apr. 1987 53 p

(Grant AF-AFOSR-0019-82)

(AD-A181135; AFOSR-87-0593TR) Avail: NTIS HC A04/MF A01 CSCL 03B

In the 1970's an observational technique for the study of solar oscillations with periods longer than 5 min was developed at SCLERS. The technique yields information about the temperature eigenfunction of an oscillation at the extreme solar limb. The primary goal of the observational program for 1982 to 1986 was to use this technique to systematically increase the data base for the study of solar oscillations. Because of the complexity of the eigenfrequency spectrum and because of the relatively small signals produced by the oscillations, the analysis of the observations for identification and classification of modes of oscillations has proved to be very difficult. The main objective of the data analysis program for 1982 to 1986 was to develop analysis techniques which would lead to mode classifications based on the SCLERA differential radius observations and on the combination of the differential radius observations with differential velocity observations. The goal of the theoretical program has been the inversion of the multiplet fine structure obtained in the data analysis program in order first to test if for internal consistency and second infer information about the radial and latitudinal dependence of the internal rotation of the Sun. GRA

**N87-27585*#** Smithsonian Astrophysical Observatory, Cambridge, Mass.

**AN INVESTIGATION OF SHORT PERIOD OSCILLATIONS OF THE SOLAR IRRADIANCE AND THEIR TIME VARIATIONS Final Technical Report, 15 Feb. 1985 - 14 Dec. 1986**

Robert W. Noyes Aug. 1987 12 p

(Grant NAG5-506)

(NASA-CR-180340; NAS 1.26:180340) Avail: NTIS HC A02/MF A01 CSCL 03B

Measurements of solar irradiance fluctuations by the Active Cavity Radiometer (ACRIM) instrument onboard the Solar Maximum Mission (SMM) show variations on a time scale of about 5 minutes due to solar p-mode oscillations, as well as longer-term variations related to solar magnetic activity. The question was studied whether the p-mode frequencies change with time as a result of changing solar structure associated with the activity cycle. The ACRIM data on SMM are particularly well-suited for this purpose, because the instrument operated continuously from February 1980 to December 1980 and again from May 1984 to the present. The main activity entailed a detailed study of the observational data to determine if a change in the p-mode frequencies is evident from the time of solar maximum to that of solar minimum. It was concluded that the measured eigenfrequencies were significantly higher during the 1980 time frame than during the 1984 to 1986 time frame. The conclusion that there is significant change in the eigenfrequencies with the activity cycle remains only tentative, and needs confirmation from analysis of more data during the upcoming solar maximum. Author

**N87-27586#** National Oceanic and Atmospheric Administration, Boulder, Colo. World Data Center A for Solar-Terrestrial Physics.
**SUNSPOT NUMBERS: 1610-1985 BASED ON THE SUNSPOT-ACTIVITY IN THE YEARS 1610-1960**
J. A. McKinnon Jan. 1987 115 p
(PB87-184198; UAG-95; LC-75-643289) Avail: NTIS HC A06/MF A01 CSCL 03B

Contained are: (1610 to 1985) minima and maxima of sunspot number cycles; (1700 to 1985) yearly mean sunspot numbers (table and graph); (1749 to 1985) monthly mean sunspot numbers (tables and graph); (1749 to 1985) smoothed monthly mean sunspot numbers (tables and graph); and (1818 to 1985) daily sunspot numbers (tables and graph). GRA

**N87-27587#** National Geophysical Data Center, Boulder, Colo.
**SOLAR-GEOPHYSICAL DATA NUMBER 511, MARCH 1987. PART 1: (PROMPT REPORTS). DATA FOR FEBRUARY, JANUARY 1987 AND LATE DATA**
Helen E. Coffey, ed. Mar. 1987 118 p
(Contract N00014-86-F-0049)
(PB87-186375; SG-511-Pt-1; ISSN-0038-0911; LC-79-640375)
Avail: NTIS HC A06/MF A01 CSCL 03B

Solar-geophysical data presented include: Detailed index for 1986 to 1987 (advance and worldwide IUWDS alert periods; solar activity indices; solar flares; solar radio emission, Stanford mean solar magnetic field); data for January 1987 (solar active regions, sudden ionospheric disturbances; solar radio spectral observations; cosmic ray measurement by neutron monitor, geomagnetic indices, radio propagation indices); and late data (solar activity indices, Pioneer XII interplanetary magnetic field magnitudes, cosmic ray measurements by neutron monitor Kiel/Tokyo July 1986, geomagnetic indices November-December 1986, calcium plage data September-November 1986). GRA

**N87-27588#** National Geophysical Data Center, Boulder, Colo.
**SOLAR-GEOPHYSICAL DATA NUMBER 511, MARCH 1987. PART 2: (COMPREHENSIVE REPORTS). DATA FOR SEPTEMBER 1986 AND MISCELLANEA**
Helen E. Coffey, ed. Mar. 1987 85 p
(Contract N00014-86-F-0049)
(PB87-186383; SGD-511-Pt-2; ISSN-0038-0911; LC-79-640375)
Avail: NTIS HC A05/MF A01 CSCL 03B

Solar-Geophysical Data Number 511, March 1987. Part 2 (Comprehensive Reports). Data for September 1986, and Miscellanea, contains the following: Detailed index for 1986 to 1987; Data for September 1986 - Meudon Carte Synoptique; Solar flares; Solar radio bursts at fixed frequencies; Solar X-ray radiation from GOES satellite; Mass ejections from the Sun; Active prominences and filaments; and Miscellaneous data - Interplanetary solar plasma. GRA

**N87-27589*#** Smithsonian Astrophysical Observatory, Cambridge, Mass.
**A NORMAL INCIDENCE HIGH RESOLUTION X-RAY TELESCOPE FOR SOLAR CORONAL OBSERVATIONS Semiannual Progress Report, 1 Feb. - 31 Jul. 1987**
Leon Golub Aug. 1987 26 p
(Grant NAG5-626)
(NASA-CR-181225; NAS 1.26:181225; SAPR-6) Avail: NTIS HC A03/MF A01 CSCL 03B

The preflight preparation of the multilayer mirror fabrication and testing, integration and testing, and WSMR activities are described. Post-flight analysis shows that all payload systems and subsystems performed well within acceptable limits, with the sole exception of the light-blocking prefilters. Suggested corrective actions were discussed. Refurbishment and reflight are then described. B.G.

# 93 SPACE RADIATION

Includes cosmic radiation; and inner and outer earth's radiation belts.

For biological effects of radiation see *52 Aerospace Medicine*. For theory see *73 Nuclear and High-Energy Physics*.

**N87-27590** Washington Univ., Seattle.
**OBSERVATIONS AT MILLIMETER WAVELENGTHS OF SMALL ANGULAR SCALE ISOTROPY IN THE COSMIC BACKGROUND RADIATION Ph.D. Thesis**
Simon John Elliott Radford Jan. 1987 164 p Sponsored by the John and Mary R. Markle Foundation
Avail: Univ. Microfilms Order No. DA8706653

This dissertation reports an experiment to determine the amplitude of cosmic background radiation (CBR) anisotropies. Observations at a wavelength of 2.2 mm were made with a far infrared photometer based on a composite semiconductor bolometer cooled to 0.35 K by evaporation of He-3. The photometer was operated in conjunction with a 9 m Cassegrain telescope. A sampling technique was developed that substantially reduces the effect of atmospheric noise. The result of five nights of observation is an upper limit to CBR anisotropies of (delta T)/T(CBR) less than 1.2/10,000 at the 95 percent confidence level. In addition to demonstrating the performance of the apparatus and the efficacy of the sampling technique, this result is sufficient to constrain some currently popular cosmological models, excluding a baryon dominated universe for example. Dissert. Abstr.

**N87-27591#** Los Alamos National Lab., N. Mex.
**PREDICTING THE PRODUCTION RATES OF COSMOGENIC NUCLIDES IN EXTRATERRESTRIAL MATTER**
R. C. Reedy 1987 26 p Presented at the 4th International Symposium on Accelerator Mass Spectrometry, Ontario, Canada, 27 Apr. 1987
(Contract W-7405-eng-36)
(DE87-009008; LA-UR-87-1397; CONF-8704112-1) Avail: NTIS HC A03/MF A01

The production rates of nuclides made by the galactic and solar cosmic rays are important in the interpretations of measurements made with lunar samples, meteorites, and cosmic spherules. Production rates of cosmogenic nuclides have been predicted by a variety of methods that are reviewed in this paper, ranging from systematic studies of one or a group of meteorites to purely theoretical calculations. Production rates can vary with the chemical composition and the preatmospheric depth of the sample and with the size and shape of the object. While the production systematics for cosmogenic nuclides are fairly well known, the ability to predict their production rates can be improved, with a corresponding increase in the scientific return. Additional detailed studies of cosmogenic nuclides in extraterrestrial objects are needed, especially for fairly small and very large objects. Nuclides made in simulation experiments and cross sections for many major nuclear reactions should be measured. Such studies are especially needed for the long-lived radionuclides that have only recently become readily measureable by accelerator mass spectrometry. DOE

**N87-27592#** Stockholm Univ. (Sweden). Inst. of Physics.
**A COMMON UNDERSTANDING OF SEVERAL COSMIC RAY ANOMALIES**
N. Yamdagni Dec. 1986 9 p
(USIP-86-14; ETN-87-90079) Avail: NTIS HC A02/MF A01

Centauro, Geminion and Chiron cosmic ray anomalies are discussed. A threshold in the electromagnetic shower development is suggested. Above the thresold, the electromagnetic shower frequently contains hadrons. This anomalous shower development can explain the muon signal from Cygnus X-3 observed by underground detectors. ESA

# 99 GENERAL

**N87-27593*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.
**[ACTIVITIES OF THE JET PROPULSION LABORATORY] Annual Report, 1985**
Apr. 1986 63 p
(NASA-CR-181199; NAS 1.26:181199; JPL-400-284) Avail: NTIS HC A04/MF A01 CSCL 05D

Work accomplished by the Jet Propulsion Laboratory (JPL) under contract to NASA in 1985 is described. The work took place in the areas of flight projects, space science, geodynamics, materials science, advanced technology, defense and civil programs, telecommunications systems, and institutional activities.
J.P.B.

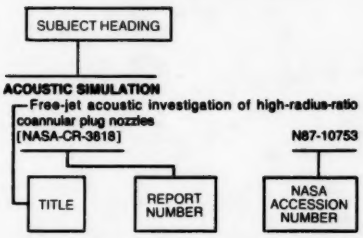
**N87-27594#** Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
**LA RECHERCHE AEROSPATIALE, BIMONTHLY BULLETIN, NUMBER 1986-4, 233/JULY-AUGUST**
Claude Sevestre, ed. Feb. 1987 67 p Transl. into ENGLISH of La Recherche Aerospatiale, Bulletin Bimestriel (paris, France, ONERA), no. 1986-4, 233/Jul.-Aug. 1986, Feb. 1987
(ESA-TT-1025; ETN-87-90018) Avail: NTIS HC A04/MF A01; print copy in ENGLISH available at ONERA, Paris, France FF 75; original report in FRENCH available at ONERA, Paris, France FF 75

A program for computing the pogo stability of a liquid propellant launch vehicle; ordering effects in metallic alloys; hydroelasticity of slender bodies in an unbounded fluid in the medium frequency range; and crack initiation and propagation due to cyclic thermal gradients are discussed.
ESA

**N87-27595#** Office National d'Etudes et de Recherches Aerospatiales, Paris (France).
**LA RECHERCHE AEROSPATIALE, BIMONTHLY BULLETIN NUMBER 1986-3, 232/MAY-JUNE**
Claude Sevestre, ed. Paris, France Dec. 1986 78 p Transl. into ENGLISH of La Recherche Aerospatiale, Bull. Bimestriel (Paris), no. 1986-3, 232/May-Jun.
(ESA-TT-1007; ETN-87-99851) Avail: NTIS HC A05/MF A01; print copy in ENGLISH available at ONERA, Paris, France FF75; original report in FRENCH available at ONERA, Paris, France FF75

Three dimensional boundary layer computation on arbitrary obstacles with direct and inverse methods; the breakdown of a vortex generated by a delta wing; separation structure on cylindrical wings; and internal acoustics in turbomachinery are discussed.
ESA

## Typical Subject Index Listing

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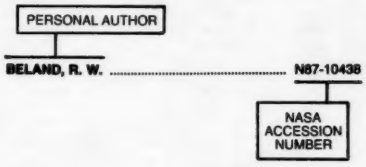


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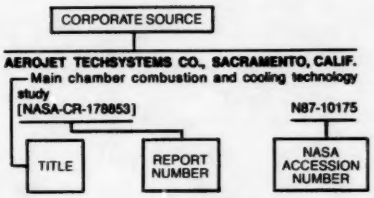


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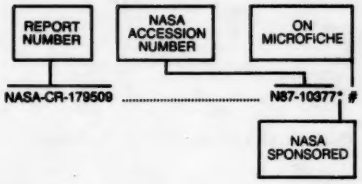


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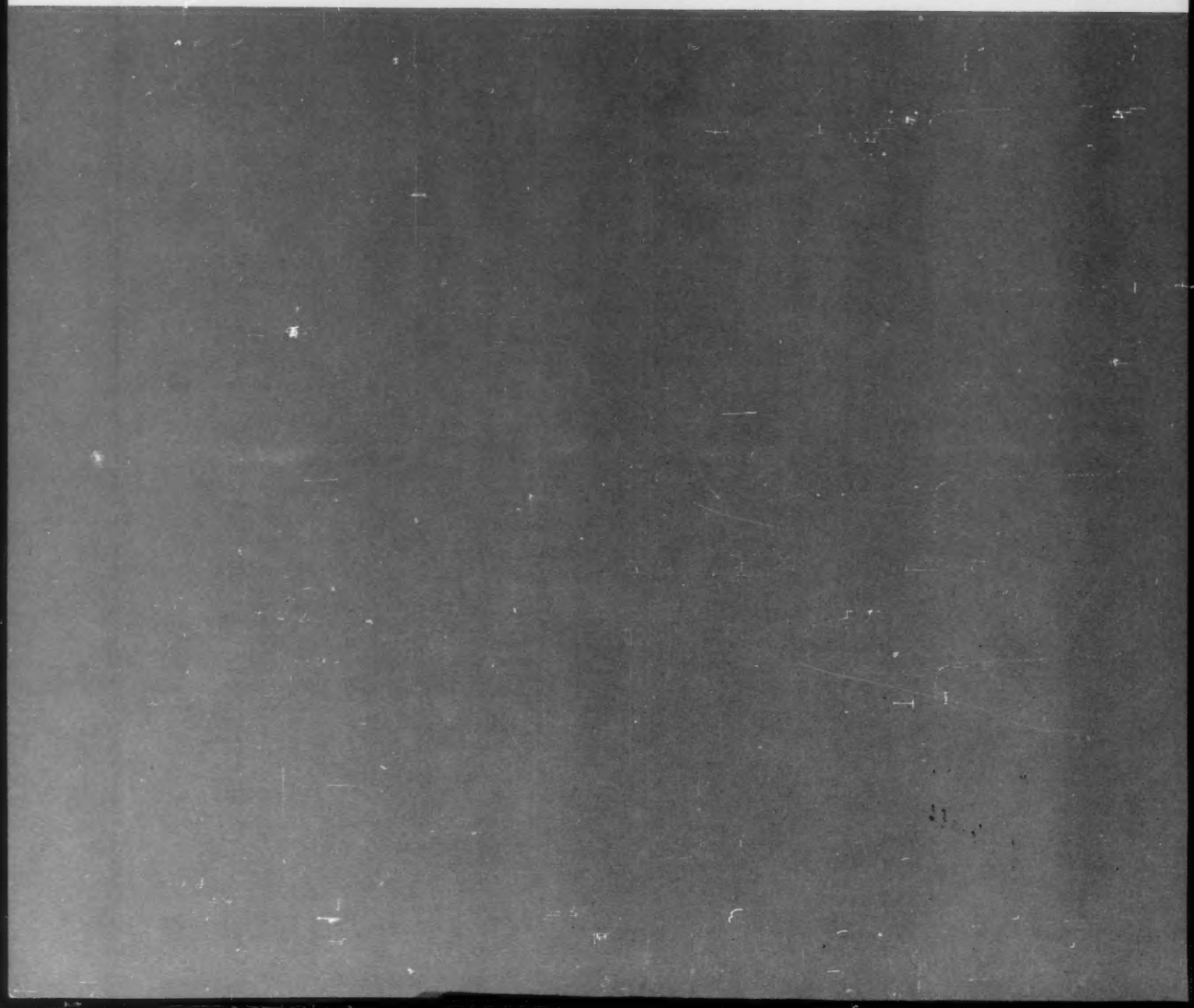
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